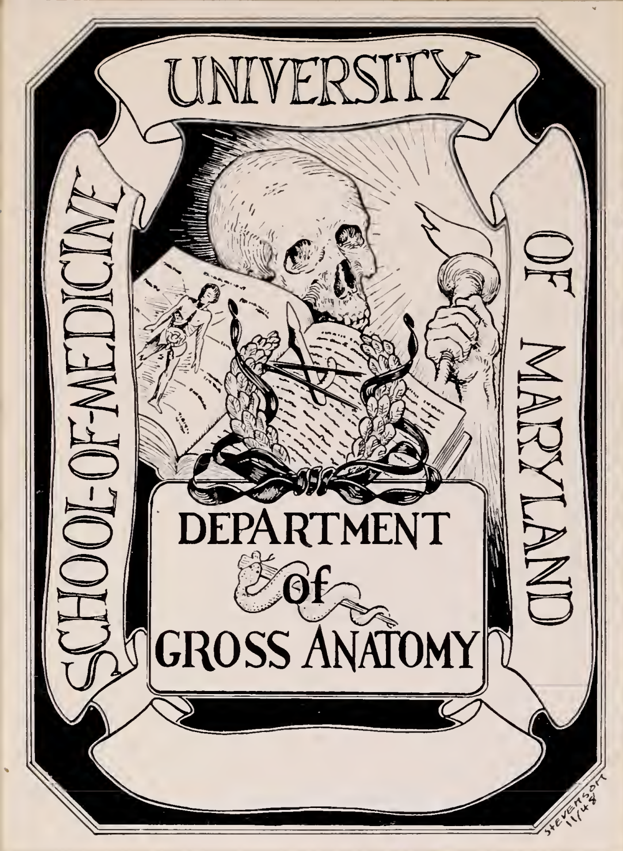


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Feisenberger & Gurney, Ltd.
Mar. 30, 1951. Price: L3.10.-
$9.83

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1827

Bell, John

THE

# ANATOMY AND PHYSIOLOGY

OF THE

# HUMAN BODY.

BY

JOHN AND CHARLES BELL.

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*THE SIXTH EDITION:*

IN WHICH THE WHOLE IS MORE PERFECTLY SYSTEMATIZED AND CORRECTED

By CHARLES BELL,

PROFESSOR OF ANATOMY AND SURGERY TO THE ROYAL COLLEGE OF SURGEONS OF LONDON;
FELLOW OF THE COLLEGE OF SURGEONS OF EDINBURGH;
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IN THREE VOLUMES.

VOL. II.

LONDON:

PRINTED FOR

LONGMAN, REES, ORME, BROWN, AND GREEN,

PATERNOSTER-ROW;

AND T. CADELL, STRAND.

1826.

London:
Printed by A. & R. Spottiswoode,
New-Street-Square.

THE

# ANATOMY

OF THE

# HUMAN BODY.

## VOL. II.

CONTAINING

THE DESCRIPTION

OF

*THE ARTERIES AND THE VEINS,*

*THE ABSORBING SYSTEM,*

AND

*THE BRAIN AND NERVES.*

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# INTRODUCTION

TO

# THE SECOND VOLUME.

THE discovery of the circulation of the blood has been always regarded as one of the most important, and has been ranked rather with the great doctrines of philosophy, than with the discoveries in our peculiar science: it has been boasted of by our countrymen, and much coveted, and often claimed, by strangers; it is indeed a discovery the most ingenious and beautiful.

How the well-proved doctrines of Harvey were perverted; what new, strange, monstrous, and impossible circles his antagonists contrived for the blood, it were tedious to relate: but it is most natural to mention why his doctrines were opposed. It was the universal opinion in those days, that the blood was formed in the liver, and sent out from it by all the veins to nourish the body, proceeding outwards during the day, and returning by night. The old physicians had thus entered into a train of thinking which it was not easy to change: these notions about the blood were become great and important doctrines, and had descended to them from their oldest teachers, with many weighty dependencies, conclusions, and rules of practice issuing from them: they were as articles of faith which it was a heresy to forsake; and it was easy to foresee, that should the Harveian doctrine prevail; should it be once completely proved that the blood moved outwards along the arteries,

and returned by the veins; then all the reasonings of the physicians would be confounded; their theories embracing the whole body of physic disturbed; their system of practice entirely overthrown; and all they had written themselves, and all the ancient books which they had read with so much diligence (for they were really learned); all that they had ever been proud of, was to be wiped out from the thoughts of that and all succeeding ages!

But the doctrine of Harvey did at last prevail, dispelled those idle dreams of humours and temperaments, and spirits, and blood! — of the blood concocted in the liver, and moving outwards along the veins to nourish the body; of the blood moving outwards during all the day, and returning by night; of the arteries carrying air only or vital spirits, to animate the system by mixing with the blood, while the veins alone conveyed the proper blood. Yet this theory of the illustrious Harvey introduced general doctrines more mischievous in all their consequences than those which had just vanished; as, that the blood was composed of particular globules, the larger globules of smaller ones, and these again of globules of a third series; and that the arteries were so proportioned to the diameters of those globules, and descended by steps so regular and uniform, that each kind of artery had its peculiar globule which it received with ease, while others were rejected; or, if unhappily driven by a too violent action into vessels which they did not suit, were arrested in their progress, and produced either some local inflammation or some universal disease. These are the once famous doctrines of Malpighi, Boerhaave, and all the great men of their day; and which they dilated into various forms, and adorned with the fine words of lentor, remora, error loci.

To these succeeded the mechanical physicians, who, by unintelligible problems of mathematics and algebra, (reasonings which were ill-founded in their principles, even had the calculations been correct,)

pretended to estimate the force of the heart, the velocity of the blood, the power of the arteries, the strength of the veins, and the shape and size of each secreting orifice, according to the secretion which it had to perform. These were the doctrines, these the discoveries, which rendered famous the names of Bellini, Pitcairn, Keil, Hales, and other mechanical physicians, whose books are no longer of authority, and are consulted only for the history of opinions.

The chemists next soon turned their thoughts, from the vain search after the universal solvent, and the philosopher's stone, to pharmacy and the useful arts. By the abilities and industry of Newman, this branch began to assume the more respectable appearance of a useful art: it began to be allied to science, and its connexion with medicine was found to be of the most direct and important nature.

Having analysed the materials of the druggist, the chemists proceeded to analyse the parts of the human body to which those medicines were to be applied: but from this rational commencement followed one of the most trivial of all the miserable doctrines with which our science has been disgraced; for as the chemists had already explained the properties of the salts, metals, earths, and of all active substances, by the angles, cubes, or other forms which they saw their particles assume, they soon persuaded themselves that such forms as cubes, wedges, spiculæ, &c. existed in the blood; and acid and alkaline humours, sharp, corrosive, irritating, and pointed particles, were the terms in which they expressed their most admired theories; and acids, alkalis, and metals, and medicines for rounding the pointed particles, or obtunding (as they termed it), or sheathing, or covering the acrimonious humours, were their chief preventatives and cures.

Until the present day this fault has pervaded all the great theories, that in describing our vessels physicians have continued to use the language of hydraulics and hydrostatics; of a philosophy applicable

only to rigid tubes: in short, in describing the living system, they have forgotten that it was endowed with life.

We also may have erred in our turn: but with whatever degree of contempt we may view the doctrines of these older authors; or however succeeding generations may be amused with ours — still this is plain, that the most important facts in all anatomy, and the chief doctrines of the human body, must always accompany the explanation of those two great functions of the heart and lungs. Of course, the constitution of the blood; the chemistry of airs; our dependance, so incessant and immediate, upon the atmosphere in which we live; the various and singular ways by which the fœtuses of different creatures, or the creatures themselves, according to their peculiar modes of life, draw their existence from the atmosphere; the various kinds of circulation by which this air is distributed through the system of each; the effects of air particularly upon our body; and the effects also of accidents, deformities, and diseases, in those prime organs — all this wide circle of physiology belongs, in the strictest and clearest sense, to the anatomy of the heart. For one chief purpose in studying the anatomy of the human body is to understand its functions, and to compare them with those of other creatures, till we arrive at last at some distinct conception of the whole; of the various structures of animals and vegetables; and of the various functions which in each of these classes support life, and action, and through it the principle of life.

There is no occasion on which this desire of knowledge, this willing admiration of the wonders of nature, is so strong as on first studying the functions of the lungs and heart; for upon the conjoined offices of the heart and lungs all perfect life seems to depend. And how universal these two functions are; how necessary to the support of the greater animals; how essential also to the constitution of the meanest insect — it shall be my business to explain.

The knowledge of the arteries again bears along with it the whole anatomy of the human body. The nerves accompany the arteries; the lymphatics and veins twine round them; the glands and various organs are composed of them. The intimate structure of parts is known only by understanding the forms of their vessels; and as each individual part is nourished by arteries, he who has studied the arteries thoroughly knows the whole.

But to the surgeon the knowledge of the arterial system is valuable beyond all calculation or belief. He performs no operation in which arteries are not engaged; he cures no great wound in which arteries are not first to be tied; he enters into no consultation in which the arteries are not first spoken of. Without a knowledge of the arteries, he can neither think sensibly nor act safely.

Most unhappily all this comes to be known at that period of life when the deepest conviction can produce only fear and perplexity, sorrow and regret. Yet, strange to tell, there is no such conviction; no regret, no irresolution, no perplexity, is ever seen.

If the negligence with which anatomy is studied may stand excused on any account, it is on this only, that anatomists have been accustomed to write, not for the public, in plain and simple language, but for each other, in an unknown tongue. By this I mean not a foreign or a dead language, but a peculiar style and phrase which no one can understand unless he be initiated; unless he have studied the science itself so intensely, that he has also learned the jargon in which it is conveyed: in short, no one but a thorough anatomist can understand the language of anatomy, nor can even he understand it without some labour. Anatomists have buried their science under the rubbish of names; there is not a difficult or hard-sounding word upon which they have any claim that they have not retained: they have choked their subject with useless minutiæ; they have polluted their language, by transferring to it from Latin many words

which, by their continual inflections, in that language were beautiful; while their unvaried, uncouth termination in ours, is barbarous in the utterance, while it tends but to interrupt and puzzle the sense.

An anatomist, for example, will describe an artery as "going to the radial edge of the second metacarpal bone: then supplying the abductor and flexor muscles; then going along the bone of the first phalanx, seated upon this second metacarpal bone;" with many other distortions, ambiguities, and little contrivances, to conceal (as one would believe) that he is describing so simple a matter as the artery of the fore-finger: which the reader at last finds out either by some lucky chance, or by reflecting how many metacarpal bones there are; and then reckoning them first forwards and then backwards, that he may be sure which it is that the author means; for his author may count from the little finger towards the thumb, or from the thumb towards the little finger; or he may have a fancy of leaving out the thumb, and reckoning only four. What must be the surprise of any well-educated young man when he reads in those books which he must study, of the regions of the elbow or thumb, or fore-finger? And if an anatomist understands such things with difficulty, how distressing must they be to the student!

This is the scholastic jargon which has so long been the pride of anatomists and the disgrace of their science; which has given young men a dislike for the most useful of all their studies; and which it is now full time to banish from our schools. These are the authors who avoid plainness as if it were meanness; who are studious of hard words as if they constituted the perfection of science: "it is their trade, it is their mystery, to write obscurely;" and full sorely does the student feel it.

Want of arrangement, again, has still worse effects. Confusion is a monster in science.

If I should tell my reader that there are very nearly one thousand arteries in the body, going promiscu-

ously to bones, ligaments, bowels and glands, muscles, and nerves, to a thousand unconnected difficult parts, all of which he must know by name, how would he be affected! But when I observe, that these go to the neck, the head, the arm, the leg, he begins to see this confusion of muscles, and glands, and bowels, vanish, and to perceive that all these arteries may be usefully and very simply arranged. When he is next taught to know the course of each greater artery, and the parts in which each division and branch of it lies, he perceives clearly that the parts through which it runs, as the arm-pit, neck, or groin, must limit and regulate the number of its branches, and give to each twig even an appropriate place and name: when, next, the whole arterial system is marked and chalked out for him in different portions; when there are points of peculiar importance set apart which he is charged to learn with particular care — he sees a good end in all this toil; he begins with courage, and gets forward easily; it becomes an interesting, and of course a pleasing task; but still it is a task: and I entreat the young student, as he values his own honour, or the safety of his friends, not to bate himself one iota of the whole. Let him not take an indolent advantage of those arrangements which are meant to promote his industry, not to prevent it. Let him not read only concerning the greater arteries, neglecting the smaller ones, but go through the whole piece of anatomy honestly and fairly. He will no doubt forget in time the smaller arteries; but by having studied even them with diligence, he must remember the great and important arteries with a clearness of comprehension and arrangement, which those who have not gone thus honestly through the whole study can never attain. Let him also remember that studies like these, well performed during his early years, do, like past dangers, or the remembrance of good deeds, give an ease and pleasure to his after-life.

The arteries, I will now venture to say, should be with the surgeon as familiar as his name; and there

is no argument which proves it more strongly than this, that a man of real learning, of sterling good sense, of a clear head and steady hand, a man accomplished in all other respects, and fitted by nature and genius for performing the most difficult operations, if yet he want this part of knowledge, may, in one unhappy moment, do things which he must think of with horror during all his life. I know well how such little accidents are thought of, when at last the evil day comes. A surgeon hardly believes this strict knowledge of the arteries to be so great a point. In the midst of an operation, or in a common wound, it gives him no concern to see arteries bleed which he did not look for; nor has he great reluctance to drive his needle among parts which he does not know. An artery bleeds, and he looks for it; he calls out at last to screw the tourniquet, and it stops; the tourniquet is loosened again, and again it bleeds; again the screw is tightened on account of the loss of blood; he expects to strike the artery; he is accustomed to strike it, not by knowing where it lies, but by seeing it bleed: at last some lucky dab of the needle succeeds, or perhaps from faintness of the patient the bleeding ceases: the surgeon is relieved from his present anxiety; but in a few hours he is called back to this scene of confusion and dismay; yet at last the bleeding is somehow or other mastered; and thus he gets on through all his difficulties, accident after accident, operation after operation, till at last he almost forgets that anatomy was a branch of his education, or the knowledge of blood-vessels necessary in operations or wounds.

I will not say that a man cannot suppress a bleeding from a wound in the arm, because he is not acquainted with the anatomy of the arm; but this surely I may be allowed to say, that it is a piece of knowledge which at all times, but especially in those circumstances, can do no harm; and that if you leave a patient to choose betwixt two surgeons, one skilled in the knowledge of arteries, another knowing them

only by seeing them spout out blood, it is easy to foretel where his choice will fall.

Perhaps some will be so hardened as to say, "and yet we seldom hear that patients die of bleeding." Is it then a merit that your patient is not plainly killed; that he does not expire under your hands? Is it nothing to lose blood from day to day? Is it nothing that your patient is reduced to extreme weakness, suffering every thing but actual death? Is it nothing that he lies with tourniquets round the limbs in fear and anxiety, attended by young surgeons appointed to watch that bleeding, which may burst out while the patient turns in bed, and destroy him in one moment? Is it nothing to have fresh incisions and new searchings for the artery to endure? These are real difficulties and dangers, and they should be provided for; our honour as well as our duty requires it. Bleeding from a great artery is to the patient the greatest danger; the very report of an ill accident is to the surgeon, (though God knows he may be blameless,) the greatest disgrace; and, lastly, though it should not be so, his taking up a bleeding artery dexterously and quickly, when others have failed, is a great honour.

When we think of all the important consequences of being thoroughly versed in this part of anatomy, they crowd upon our imagination more in number than can be even named. The surgeon may, indeed, provide for the arteries to be cut in a regular operation, by consulting books; but when he is called to a patient bleeding and faint, perhaps expiring, that person must live or die by his immediate skill! By his skill he will obtain the good opinion, not of ignorant attendants only, but of the profession: and by a bold and sensible conduct in any difficult situation he may give him a lesson of real use. Let us but for a moment think of the chances of those wounded in war; the alarming unthought-of accidents which overtake us daily in private life; the wounds and hurts which workmen receive; let us reflect on all

the kinds of aneurism both in the heart and arteries, from wounds, from blows, from inward diseases; let us think of all the various operations in which arteries are concerned—and then declare whether, of all his studies, the young man should not value that most which makes him so immediately aud eminently useful.

# OF THE HEART,

AND OF THE

# ARTERIES, VEINS, AND LYMPHATICS.

## RESPIRATION continued.

RESPIRATION, OR THE MANNER IN WHICH THE OXYDATION OF THE BLOOD IS ACCOMPLISHED IN VARIOUS ANIMALS.

THOSE who are the best acquainted with the comparative anatomy will best know how natural it is for me to illustrate this function, by comparing various animals with man: how pleasant, how useful, it is to know these analogies, every student must feel; and it is now full time to correct many mistakes into which modern as well as ancient authors have wandered, from want of general principles, and from want of anatomical knowledge. I shall endeavour to make this chapter interesting and short.

At one time all authors believed that the lungs were moved, not by any external agent, but by some internal power residing in the lungs.

When in their first essays to investigate this subject they opened the thorax, or rather the body, of amphibious animals, they observed that the creature lay out upon the table with expanded lungs; that the lungs continued for hours to appear like inflated bladders;

the lungs expanded, the heart playing, the creature quite alive. When they emptied their lungs for them by thrusting tubes down the trachea, or pressing the lungs, the lungs entirely subsided; but in a little while the lungs, at the creatures's will, rose again into complete inflation; again they appeared like two tense bladders. Surely, said they, there resides some expansile power in the lungs themselves; but when a few of them began to pursue this mistake with serious experiments, they committed absurdities which should be noticed, for they serve to illustrate the true doctrine concerning the expansion of the lungs.

Mr. Houston, in our philosophical transactions, undertook to prove the following thing, which, to use the words of a learned author, "are so improbable as to be incredible:" first, that the breathing of a dog is nothing affected by any wound of the thorax, if only the lungs themselves be not hurt: secondly, that the lungs never collapse, though the thorax be laid open; thirdly, that when the breast is entirely laid open, the lungs continue to move, and the thorax also continues to move, but that the motion of the thorax never keeps time with the motions of the lungs. But, to do Houston justice, he endeavoured to explain away the inconsistencies of his own experiments; and the world would never have been troubled any more with them, had it not been for a Mr. Bremond, a great academician, philosopher, and experiment-maker, who published the following suite of experiments in the academy of Paris.

His first mistake is this. "I found (says he) that having stabbed a Dog in one side only, it could run about the house and howl." This is what nobody will doubt. "But also (says he) the air which the Dog took in by the wound when it expired, was pressed out again by the wound when it inspired." This is one cunning stroke of Mr. Bremond; for had the air entered the chest during inspiration, that must have proceeded from the rising of the thorax, which

is not the kind of respiration which he wanted to prove: but as the air entered the chest during expiration, it proceeds clearly, according to his principles, that the lungs in squeezing out their air have a contractile power; that they contract by their own motion, and leave the ribs, and so make room for the air.

"Next (says Mr. Bremond) I opened the thorax of a living Dog, and there I saw, that when the lungs contracted the thorax dilated, and when the thorax contracted the lungs dilated."—But in fact, it means no more than this, that often in these agonies produced by such cruel experiments upon animals, or by actual wounds in the human body, the diaphragm, chest, every thing which contributes to breathing, is so closely contracted, and the pressure is so great, that the lungs are actually compressed and protruded: so that his seeing, as he says, the lungs dilated, that is, squeezed out, when the thorax contracted, is like the ignorance of a child looking from a carriage-window, who believes and wonders at the trees and houses running backwards. But as no experiment-maker ever allows his experiments to remain incomplete, Mr. Bremond finishes his by the following daring assertion, "that always when he made his incision no more than three inches long, the lungs dilated themselves with so much violence that they drove out the air before them, protruded themselves through the opening, and made the blood jerk out at all points." In short, he repeats this mistake in every possible form, viz. that the motions of the lungs and thorax are directly opposite to each other; that the lungs are contracting while the thorax dilates, and the thorax contracting again when the lungs dilate. When I open a Frog, it fills its lungs with perfect ease after both its breast and belly have been entirely cut away. "If admitting air into the thorax could really make the lungs collapse, why do not those of the Frog collapse?" This is such gross ignorance as should not have been endured in one reading papers before the Royal Academy of France. He is

farther back in physiology than Oligerius, Jacobæus, or Malpighi. — The Frog has a respiration peculiar to itself, or at least to its kind.

FIRST SPECIES OF RESPIRATION, VIZ. BY A DIAPHRAGM.

Under this title I shall explain the respiration of Man, and of animals like Man; which have heavy lungs, of a strong fleshy texture, a prodigious number of blood-vessels passing through them, their lungs lodged entirely in the chest, and their respiration performed by a diaphragm. — I mean to arrange respiration according to the mechanism of those organs by which it is performed; and place in the first order that of Man, and animals which in this point resemble Man; and I say respiration by a diaphragm, for this is indeed the only use of a diaphragm. The support of the great blood-vessels, the compression of the viscera, the expulsion of the urine and fœces, the ridding the womb of its burden; all could have been performed by the pressure of the abdominal muscles alone! the diaphragm is added merely for breathing.

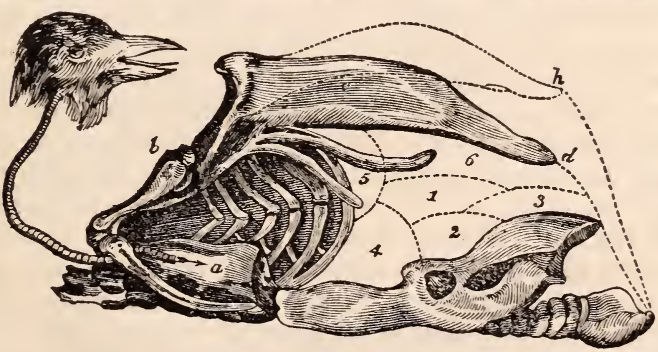
Forsaking, for a moment, authority and minute anatomy, let us explain it in the shortest and most intelligible way. — The diaphragm divides the thorax from the abdomen; it is strong, muscular, and acts with great power, enlarging the thorax; it is convex towards the breast, and concave towards the belly; when it acts the belly is protruded, the diaphragm becomes flat, the thorax is enlarged, and a vacuum would be formed, but that instantly the lungs follow it and prevent a vacuum; for the lungs are free in the thorax, the air has free access to go down into the vesicles of the lungs; and so when the diaphragm retires, the lungs follow it, being dilated by the pressure of the air which enters by the trachea.

But this protrusion of the belly excites the abdominal muscles to re-act; their pressure restores the diaphragm to its natural form; when pressed back again by the abdominal viscera, it rises in the thorax,

becomes again convex towards the lungs, the thorax is reduced in size, the lungs are compressed, and that air is driven out again which they have just received. The thorax also moves in concert with the diaphragm: and this motion is most curiously arranged; for, first, the intercostal muscles lift the thorax for respiration, in the very moment in which the diaphragm is pressing down, and consequently at the instant when the abdominal muscles, which are attached to the lower borders of the thorax, are relaxed, so that they suffer it to rise. Next, the thorax is to be compressed and pulled down by the abdominal muscles: and this happens at the very instant in which the abdominal muscles re-act against the diaphragm; so that the abdominal muscles, while they thrust back the diaphragm, pull the lower edges of the thorax down with great power.

Thus in Man, and almost all animals, the respiration is performed by a diaphragm.

SECOND SPECIES OF RESPIRATION, VIZ. THAT OF BIRDS.




This figure represents the apparatus of respiration in a bird. *a* is the solid lungs, which are not moveable; *b*, *c*, the bones of the body, the breast-bone *c* extending the whole length of the body; 1, 2, 3, 4, 5, 6, the air-cells occupying the thorax and abdomen, which are here one cavity, or rather series of cavities. These are dilated when the chest rises to the line *h*.

Birds are supposed to breathe like Man, but have in fact no diaphragm to divide their body; they have

vesicles, or air bags extending through the whole body, and connected with the true lungs; their sternum and ribs expand over the whole, and by their motion move the air vesicles, which blow the air through the true lungs; while the true lungs, far from having any thing to do with a diaphragm, never move.

Every one skilled either in anatomy or physiology must know, that one of the greatest physiologists of our times has written a paper about the respiration of birds, little understood, and in proportion much admired; of which function he is so thoroughly ignorant, as to explain how they breath with a diaphragm; and until I set this point right, my arrangement is good for nothing.

"The diaphragm of fowls (says Mr. Hunter) is thin, transparent, and membranous, and runs across the abdomen." But if thin, membranous, and transparent, it can perform none of the functions of a diaphragm, and must be merely such a membranous interseptum as some Amphibia and Reptiles have, supporting the viscera, or confining them in their place. But he thinks to make good his point by acknowledging the imperfection of this diaphragm; and adding, that it is moved by certain small muscles, which arise from the inner surface of the ribs, and pull the diaphragm and lungs down. He still persists in calling it a diaphragm, in the very sentence in which he informs us that "it is perforated in many places with holes of a considerable size." Since Mr. Hunter is so bold as to say of other authors, that they have too limited notions of a diaphragm, we may be allowed to say, that his notions of it are as much too liberal as theirs are too confined. But descriptions and arguments of this kind, where the author is entirely wrong, should not be tediously refuted, nor answered in any other way than by a simple statement of the case.*

* For the respiration of birds, *i. e.* for raising and depressing the thorax, I see many muscles having a very strong analogy with

The anatomy of a fowl's respiratory organs is plainly this:—The trachea having descended into the thorax, divides into two branches; of which one goes in a simple and ordinary manner into each side of the lungs. The heart, which lies immediately upon this division of the trachea, sends into the lungs two great pulmonic arteries, and receives in return two veins. The lungs themselves are very small, dense, and bloody; they are somewhat of the shape of the human lungs; they are seated in the very uppermost part of the chest, are closely braced down to the back, and are indeed in part niched in among the ribs, which in birds have their edges very deep. These are the true lungs for oxydating the blood; they never move; the air passes through them in the following way.

These lungs cannot move, because they are braced down by a membrane very thin, and cobweb-like, yet very strong. This membrane is a peritonæum, lining at once the whole thorax and abdomen, (which still are not parted from each other,) and it is a covering to the lungs, liver, and other viscera; but also the same cobweb-like membrane forms cells, which fill the whole cavity from the neck down to the anus, and from the breast-bone to the back; and which are so attached to all the surfaces, being, as I have said, the lining membrane, that as the breast moves these cells must move.

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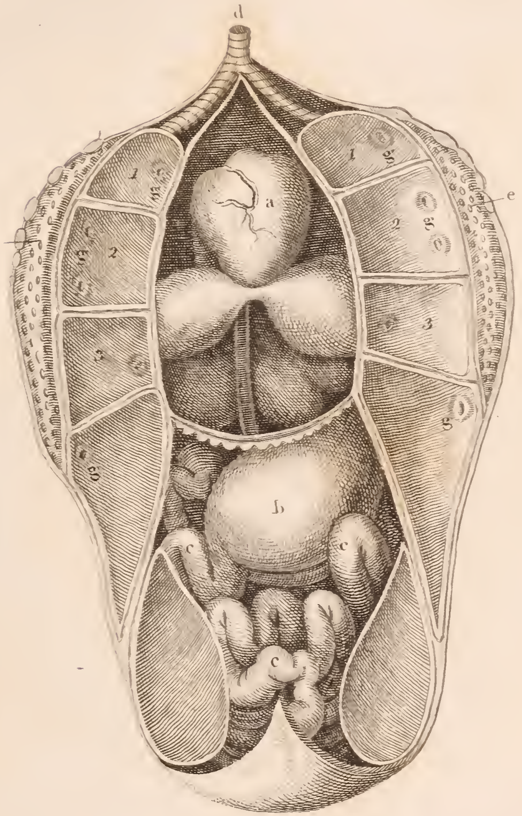
those of Man. The pectoral muscles are amazingly strong, and their scapulæ absolutely fixed, so that these could raise the breast with great power; but I suspect that no such power is needed, that the elasticity merely of the sternum and ribs raises them. There lies under these, upon the back, a very strong muscle like our serratus posticus. There lies on the inside of the ribs a set of three beautiful muscles like large intercostals: they are quite insulated from all other parts, are seen instantly upon opening the belly: these are what Mr. Hunter calls Muscles of the Diaphragm; but in truth the breast of a bird is pulled down strongly by its short, yet strong abdominal muscles, and rises again by its own elasticity with little help; and these are merely intercostal muscles.

These cells appear at first sight quite irregular; but I hold it as a principle, that, although we may not see it, yet all is orderly in the animal body; in fact, the order of these cells is extremely regular. First, there is a membrane which comes down from the breast-bone in a perpendicular direction till it touches the viscera; it runs the whole length of this common cavity of breast and abdomen; it enters into the great cleft of the liver, and so divides the liver into two lobes, serving as a ligament for the liver, as a mediastinum to divide the great cavity into two, and also as a sort of root or basis for the cells of either side; though beautifully transparent, it is very strong. At the upper end this mediastinum touches the heart, and there expands into a very large bag exquisitely transparent, which is at once an air-cell and a large pericardium. Next, at its lower end, it touches the gizzard or stomach, and forms a large cell surrounding it. Behind the liver which fills all the upper part of this great cavity, and the gizzard which fills all the lower part, lie all the intestines, which are also surrounded with many cells; at the sides the cavity is occupied by three or four large cells extending from the middle membrane to the flanks of the bird. And, lastly, when we look into those greater cells which are nearest the lungs, we see clearly many openings, very large, oblique, running flat under that part of the membrane which braces down the lungs, so as to communicate the air from the lungs to all the cells very freely.

Now let me add, in one word, that the essential parts of respiration are these: First, There is no diaphragm, no division of breast and belly, the stomach lying upon the rectum in the pelvis; a true and muscular diaphragm could not exist in birds, having nothing to do in their scheme of respiration. Secondly, The true lungs are small, high in the back, quite immoveable, so that no diaphragm nor no power of vacuum could unfold them; and these lungs

# The Ostrich's Lungs
## drawn by the Parisian dissectors




a The Heart lodged in one great Air Cell b the Stomach and c the Intestines surrounded by other great Cells. d the trachea branching towards the lungs. e e The true lungs firm fleshy. very small & fixed down to the backbone. 1 2 3 other great Air Cells in immediate contact with the Lungs & communicating with all the other Cells. the holes g g g &c are the openings by wh the Cells communicate with the Lungs & with one another

are perforated at every point, so that they could not expand by air. Thirdly, What has been confounded with the true lungs is the vast congeries of abdominal cells, which are of use only in lightening the creature that it may fly, and in forcing the air through the true lungs. Fourthly, There is in the place of a divided abdomen and thorax, with long abdominal muscles, no proper abdomen, a long thorax, a high sternum, and very elastic ribs, extending along the whole body till they almost meet the pelvis, making the abdominal muscles very short; and the air cells all along adhere to the inner surface of these bones.

With these points clearly before us, we cannot mistake the mode of respiration in birds. The thorax does the whole; the thorax is raised, and immediately the cells are expanded, by which two functions are performed; for the air which comes into the cells, passing through the lungs, oxydates the blood, and the cells become full at the same time so as to make the body specifically lighter. The thorax is depressed again, and the air, which passes now a second time through the lungs, may a second time oxydate the blood, for it is not thoroughly spoiled; and what is spoiled is diluted with the air of many cells, which respiration cannot empty at one stroke.

The final cause also is plain; had the lungs in a fowl been solid and fleshy, (as they are in fowls, or even in any other creature,) and at the same time sufficiently large to perform, without the help of those air bags, all the functions of lungs, they must have been large and heavy in proportion to the body of the fowl; they must have occupied much room, and added much to the weight. But the lungs of a fowl are very dense, very small in proportion to its system, very full of blood, quite fixed, and undilatable; the rapid course of the air through them backwards and forwards enabling them in their business of oxygenation to do much with little. In short, there are two functions to be performed in birds: first, the

oxydation of the blood, which is performed by the small, fleshy, contracted lungs, which lie immoveable in the upper part of the thorax, and through which the air blows continually as through a furnace, while they are quite passive; and, secondly, the lightening of their bodies for flying, which is performed by the abdominal cells. It was also necessary that the sternum and bony compages should be large, in order to afford space for the origin and lodgement of the muscles of the wings, and to enable them to raise the whole weight of the body in flying. The describing of a diaphragm, and the confounding of the abdominal cells with the true lungs, where none can be, was like to have put us all wrong.

### THIRD SPECIES OF RESPIRATION, VIZ. THAT OF AMPHIBIA.

This species of respiration differs from the two first in these respects; it differs from the respiration of Man, because there is no diaphragm; it differs from that of birds, for there is no chest covering the lungs. There is a short sternum, no chest, no ribs by which the lungs may be moved, there is no vacuum formed in their respiration; they fill the lungs by the working of their pharynx, that is to say, instead of the air being drawn in by the action of the thorax, it is forced down by the action of the muscles under the jaw. By the swallowing of the air, as it were, the membranous air cells are inflated; and when inflated, they are emptied by the contractions of the abdominal muscles.

The Frog, the Newt, the Camelion, the Tortoise, and many other creatures, breathe in this way; and as one of the most curious mechanisms for respiration, I shall represent that of the Frog. As I have just explained, their organs for moving the lungs are not in the chest, nor in the lungs themselves, but in the throat. Behind the root of the tongue, is the slit-like opening of the trachea; this is what is called the glottis in the human subject. We see this rima open-

ing and gasping for air when we keep the mouth distended; it has no epiglottis or valve to defend it; its own contraction is sufficient, for when closed you cannot even guess at its place; besides, the jaws force down the air into it, and the long tongue carries the food over it into the gullet.

The small nostril is a very important part of the apparatus of breathing. The Frog never opens its mouth in breathing. Looking carelessly upon this creature, we do not perceive that it ever breathes, for it lies plunged over the mouth in water. It is never seen to open its mouth; there is no motion in its sides like breathing; in short, it does not seem to breathe; and when it is provoked, (or rather through fear,) though it still keeps its mouth closely shut, its sides and back rise, and it blows itself up apparently by some internal power. But when we observe the creature more narrowly, we perceive that there is a frequent motion of its jaws, or rather of that skinny and bag-like part of its mouth which is under the lower jaw. We are apt now to fall into a worse mistake, for this bag under the jaw is alternately dilated and contracted; the mouth is never opened to take in new air; the creature seems to live all the while upon one mouthful of air, and seems to be playing it backwards and forwards betwixt its mouth and its lungs.

But, lastly, when we observe its nostrils, we find that there is in the nostrils a twirling motion for each movement of the jaws, which makes the whole process perfectly simple to our comprehension; for a Frog breathes by the nostril alone, it cannot breathe by the mouth; it never raises its mouth above water, nor opens it but to catch flies or other food. If you keep its mouth open, you see it presently struggling for breath; for its respiration goes on in the following way: its broad jaws are continually shut; they lock into each other by grooves; the mouth is completely close, and forms a sort of bellows, of which the nostrils are the air-holes, and the muscles of the jaws

which come from the os hyoides draw the draught by their alternate contraction and relaxation; and the nostrils lie so obliquely over the hole in the skull, that the least motion of them enables them to perform the office of a valve. First, there is a twirl of the nostril which lets in the air; then a dilatation of the bag under the jaws, by which the mouth is greatly enlarged and filled with air; then a second motion of that bag, by which the mouth is emptied and the lungs filled; then there is a slight motion of the sides of the creature, by which the muscles of the abdomen expel the air again; and then the twirl of the nostril and the motion of the jaw succeeds again; so that with these creatures inspiration is the swallowing of the air (but not into the stomach) by their broad expanded jaws, with their coverings driving it down into the lungs; and expiration is the contraction of the abdominal muscles driving it out again: and these two motions, when we observe a Frog attentively, are as perfectly regular as respiration in a Man. Their muscles of respiration are not the muscles of the belly, but the muscles of the jaws; and this causes the uncouth broadness of the jaws in Frogs, Newts, Lizards, Serpents, Turtles.

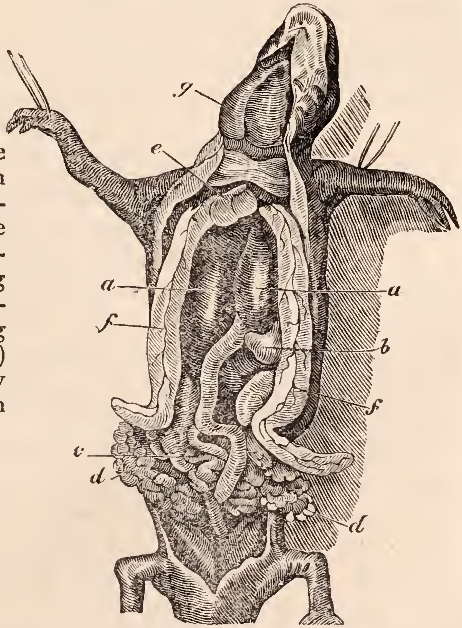
(*a*) The nostrils—(*b*) The tongue.

Now we shall no longer wonder why the Frog never opens its mouth; why it never seems to breathe; why, after opening its belly, the lungs still project; why, after emptying its lungs, it can fill them again at will, not by any peculiar power in the lungs, but by blowing them up with its jaws. If you gag the Frog and keep its mouth open, it cannot fill them, because it cannot breathe; if you plug its nos-

trils, it suffocates, though not soon; if you keep its mouth open by force, you soon find it struggling for breath; and looking into its throat, you see the glottis opening from time to time.

The Newt (or as it is called in Scotland, the Ask) breathes with the jaws and nostril like the Frog; it has, like the Frog, a constant motion by short strokes of the bag under the jaw, (which bag is formed by the membranes of the mouth, covered and moved by the genio-hyoidei and mylo-hyoidei muscles,) but we observe that every minute, or less, it stops as if intending some particular motion; then gradually the bag swells out under the lower jaw to a great size; then the air contained in it is puffed down into the lungs with a sudden flap of the bag; and in proportion as the jaws are emptied, the long sides of the creature are heaved up.

(*a a*) The liver of the Newt—(*b*) the stomach—(*c*) the intestines—(*d*) the ovaria—(*e*) the heart—(*f f*) the vesicular lungs, which are long like intestines, and transparent like the swimming bladders of a fish—(*g*) the bag of the jaws by which the lungs are blown up.




The Toad, the Camelion, the Green Lizard, breathe exactly in the same way. The Camelion has the flat broa djaws of the Frog; they lock into each other,

and it does not open its mouth in respiration; it swallows its air in mouthfuls, drives it downwards into its lungs; its lungs are of a vast extent, stretching from the jaws all along the abdomen: it is the vast size of its lungs, almost concealing the abdominal viscera, that makes Gesner say, "that of the entrails of a Camelion the lungs only are visible." The air it swallows in greater or smaller quantity as its needs or fears prompt it. When you alarm this timorous animal, it fills its sides just as a Frog swells out its back; and either in this greater respiration, or in its ordinary breathing, we see it pressing the air onwards from cell to cell; and we see the motion proceeding from its jaws to its breast, and all along its sides, till its lank form is quite puffed up almost to bursting.

All these creatures have in addition to their peculiar respiration, a peculiar kind of lungs, thin, membranous, and extremely delicate: the lungs even of so great an animal as the Crocodile are, when inflated, very delicate and transparent, of a rose colour or slight red, consisting of delicate vesicles, and exactly like the Frog's lungs. The lungs of the Frog are in shape like a fir-cone, with the stalk of the cone on each side fixed to the side of the heart. But these conical lungs of each side are delicate, silvery, perfectly transparent, divided within into innumerable cells like a honey-comb; and these also are so extremely delicate, that though the outside membrane is as transparent as a soap-bubble, the divisions can hardly be seen, except by inflating and drying the lungs, and then cutting them. The lungs of the Ask are still more beautiful, as a specimen of what are called membranous lungs; for the creature is very long in the body, its lungs run down along its sides; they are about the size of a common earthworm or writing-quill; they end like a blind gut; they are of a bluish white, exquisitely transparent, like the swimming bladder of a fish.

It is the nature of membranous lungs to oxygenate but a very small quantity of blood; they are mem-

branous, only because there is not that vast profusion of arteries, veins, and strong vesicles, which there is in the human lungs. The pulmonic artery and vein are always, in the membranous lungs, extremely small in proportion to the system which they serve.

From these peculiarities of the membranous lungs, it is plain that the oxydation of the blood is a process of less immediate necessity in their system; and thus they are the better enabled to go into the water, and to want breath for a time. But chiefly it appears, that the meaning of this peculiarity is not so much to give them the privilege of Amphibia, in allowing them to go into the water; for many creatures, as the Camelion, all the tribe of Lizards, Newts, Toads, Serpents, &c. have these lungs, and yet never approach the water: but that the chief use of it is to establish in this class of animals a peculiar constitution, a permanent, almost inexhaustible, irritability, and a tenaciousness of life; which, I believe, no creature, whether of the land or the water, wants, which has membranous lungs. And when we are told that these creatures can be kept two days under water, as a proof of their being Amphibia, I cannot but consider it as a very childish proof; for, in the first place, we see them breathing with wonderful regularity when out of the water; when plunged into the water, we see them very soon struggling for breath, and if they can live for two days without air, it is only because they could bear any other kind of injury with equal ease, and could live two days without their heart or their head. Circulation is necessary, respiration is necessary to their life, but the irritability and properties of the living parts are sustained longer without new supply than in the warm blooded animals.

### FOURTH SPECIES OF RESPIRATION, VIZ. THAT OF FISHES.

In this species of respiration the creature breathes neither water nor air, but water mixed with air, and this office is performed by gills in place of lungs.

The reason why I have called this a species of respiration, needs to be very fully explained; for, though little observed, it is a certain fact, that a creature, without any apparent change upon its system, can do well, having its blood oxygenated at one time by gills, at another time by lungs. The Frog, for example, lives long in the water; while it does so, it may be considered as a fœtus which cannot breathe: the young Frog which has not yet acquired its proper and natural respiration, breathes like a fish. For the first fourteen days after hatching from the egg, and while the Tadpole is very small, it has gills, which are two long, projecting, fimbriated appendages like fins; by the thirty-sixth day these appendages are taken into the jaws, and form four rows of gills on each side, regular, and like those of a fish; but at the same time, this fœtus has its lungs within the body, not to be used till it come out into the air, when the lungs assume their function and the gills shrink. The same system in this instance, which was at first served by gills, is in the end oxygenated by lungs.

The motion of the gills in fishes is a true and perfect respiration: for, in the first place, if there be no air in the water, or not enough of air, they cannot breathe; distilled water is to a fish what the vacuum of an air-pump is to a breathing creature: if you exhaust water with an air-pump, if you boil it, if you distil it, if in any way you deprive it of its air, fishes cannot breathe in it, but come up to the surface and gasp for air. If you take a fish out into the air, it is the same with plunging any breathing creature into water, it gasps and dies. Fishes cannot breathe in air wanting water, for that element is not accommodated to their species of lungs; nor in water wanting air, for then there is no oxygen; and we find, upon extracting the air from water which fishes have breathed, that it is contaminated, exactly in the same way with air which had been breathed by any breathing animal, and that it differs very little from that in which

a candle has burnt out. This is the reason that when many small fishes are inclosed in a narrow glass, they all struggle for the uppermost place, and that when in winter a fish-pond is entirely frozen over, you must break holes for the fishes, not that they may come and feed, but that they may come and breathe; without this, if the pond be small, they must die. Fishes according to their kind require water differently impregnated with air. The shallow water that runs over a pebbly bottom is by its agitation more thoroughly mixed with the atmosphere, and there the trout and salmon breed.

In the respiration of fishes, there are two curious points to be considered: first, the manner in which their respiration is performed; and, secondly, the manner in which their blood, when thus oxydated, is distributed over the body.

In the osseous fishes the apparatus of respiration is more like the texture of the ribs than would seem at first view. The operculum, or large flap which covers the gills, consists of arched bones, over which a membrane is stretched, and they have a very beautiful and somewhat complex system of muscles operating upon them. The margin of the operculum has a soft pliant fringe, which, in the motion of respiration, accurately shuts the slit or opening. When the creature breathes, it is by the operation of the muscles upon this covering: it is rendered convex, and the cavity under it is dilated without the margin rising; the consequence of which is, that the water is drawn from the mouth through the branchiæ, and is for a moment lodged behind them. At length the elevation of the operculum is so great that the fringed margin is raised, and then the water rushes out and is discharged backward. By this we understand why the fish keeps the head continually up the stream, and why it is the art of the fly-fisher to keep his head down the stream, or to suspend him in such a manner as to keep his mouth out of the water; for the fish cannot breathe if the water is rushing into the gills from behind, and he cannot

make use of air as he does of water, but is exhausted and suffocated.

Having explained this first point, viz. the mechanism of their gills, I proceed next to explain the circulation of their blood, how their blood is oxydated, and how it is distributed over the body.

A fish and an amphibious animal have both of them the simple heart, consisting of one auricle and ventricle, but with this singular variety, that the Frog, for example, wants the heart belonging to the lungs, a small artery only from the common system performing the office; while the fish again wants the heart which should circulate the blood through the body, and has that heart only which belongs to the lungs. The whole blood of the fish passes through this single heart, and therefore the whole mass circulates, parcel by parcel, through the gills, for every time that it circulates through the body. We shall begin its circulation, then, at the heart. First, The whole blood of the body is returned into the heart of a Skate, by two great veins. These two great veins deliver it into a vast auricle, or reservoir rather, which lies over the heart. The auricle delivers it into a strong ventricle, whose action is further strengthened by the action of its aorta, which from the heart up to where the valves are, is very muscular and powerful, and constitutes, in a manner, a part of the heart. But this great vessel must in this species of circulation change its name, for it really is not an aorta, has nothing to do with the body; both the heart of a fish, and this its only vessel, belong entirely to the lungs or gills, and as these are called bronchiæ, this is the bronchial artery. The gills of this fish are five in number on each side, and on each side the bronchial artery gives out two branches which serve the five gills; the lower branch is large, and serves the three lower gills; the higher branch, which goes off like one of the arms of a cross, serves the two upper gills.

Secondly, these arteries being distributed along

the gills, divide into exquisitely small branches producing that feathery appearance which is so beautiful. Those minute subdivisions of the bronchial vessels expose the blood to the air. This may explain to us how in the human lungs the exposing of the blood, even with the interposition of membranes and of the arterial coats, may be sufficient for the oxydation of the blood. All the blood thus oxygenated is returned by veins, corresponding exactly in number and arrangement with their arteries: and the heart being turned aside, and all the other viscera taken out, the veins are seen accompanying their arteries and emerging from the gills to form the aorta.

Thirdly, The aorta is formed by the veins of the gills, and the veins of the gills lie close upon the skull of the fish, and the aorta upon the back-bone; and this vessel is in one sense a vein, since it is a continuation of those veins which return the blood of the gills; but both in office and form it is a true aorta; in office, because it distributes blood to the whole body; and in form, because it no sooner swells out into the shape of an aorta than its coats grow hard, strong, muscular, fit for its office, while those of the veins from which it is formed are pellucid, delicate, and very tender. The aorta is full of the oxydated blood of the gills; and although, by the delicate circulation of the gills, it has lost all communication with the heart, it circulates this oxydated blood through the body to all the muscles, glands, viscera, &c. without the intervention of a new heart.

The veins which return the blood of this aorta are the ordinary veins; they arrive in two great branches at the heart, and need not be further explained.

I will not be at the trouble to repeat the tedious calculations of authors concerning the immense surface which the gills expose: let the student look to the gills, and he will presently, with the help of this short sketch, understand how the whole function goes on.

FIFTH SPECIES OF RESPIRATION, VIZ. THAT OF INSECTS.

There is in this kind of respiration no breathing organ like the lungs, but tracheæ or air tubes by which air enters into all parts of their body.

What is most perplexing in this species of respiration is the prodigious quantity of air which these creatures receive; the little connection betwixt the air tubes and the heart; the impossibility of tracing blood vessels from the heart to the various parts to nourish them; and the clearness with which we see their air tubes branching over all parts of their body. The stomach, bowels, and other viscera, the legs and wings, even the very scales of insects, have branches of the air tubes dividing over their surfaces like the delicate vessels of leaves and flowers. In short, the magnitude of these air tubes is quite surprising; and their branchings are so minute, delicate, universal over all the body, that it looks almost as if the air tube had exchanged functions with the heart and arteries.

It is plain by these expressions of admiration that I do not mean to attempt so difficult a subject as this at present: I only mention difficulties which it is surprising that others have not declared and investigated, for nothing can be more interesting. The little that we do know shall be simply and plainly told.

The forms of insects are often very strange, their lives very irregular, sometimes in water, sometimes in air; many of them begin in Worms, and end their lives as Flies and Moths; and according to these varieties of their form, or life, or generation, their air tubes are various.

Sometimes, as in the common Bee, they have nearly the form of lungs: they begin like two bags, resembling those of the Alga Marina or sea-weed, in shape; and these bags distribute pulmonary tubes, with occasional bag-like dilatations in the course of

the tubes, through all the body. More commonly the air tubes of insects are direct tubes, mere tracheæ, of a very singular construction; they have rings like the tracheæ of animals; they have a delicate membrane covering these rings, and forming them into a tube: the tube continues always rigid like a flexible catheter, or other tube of twisted wire not liable to collapse: they begin by many open mouths opening along the sides of the insect, and they terminate in myriads of vessels, which in their forms and progress over the various parts of the body, resemble blood vessels more than it is easy to conceive. These air tubes being thus rigid, are always full of air, and by their refractions through the transparent parts of the insect's body, they give it in the microscope a great degree of brilliancy; as, for example, in the Louse, whose air tubes make the brilliant lines and points which are contrasted like a silvery colour with the dark and opaque parts; or in the Mite, which is as beautiful in the microscope as the Louse; and when the larger insects are prepared by drying and varnishing, and preserved in turpentine, the air tubes are beautiful. Of these curious particulars, the openings of the air tubes are best seen in the Worm, from which the common Butterfly is produced; we count these holes down the sides, we name them puncta respiratoria, spiracula, or most commonly stigmata. That particular form in which they resemble more the lungs of animals is seen in the pulmonic bags and the tracheæ or air tubes of the common Bee. Their exquisite branchings through the various parts are well seen in the air tubes which run along the wings of a Bee, or those which twist and ramify round the intestines and stomach of a Worm; and it is not to be forgotten, that though the beginnings of these tubes in their great tracheæ and near the puncta respiratoria or stigmata are quite transparent, their extreme branches are beautifully white like vessels filled with chyle,

or rather one might be apt to mistake them for nerves.

Of the way in which this function is performed, there must be more varieties than we can know or comprehend: this we may safely conclude from the little that we do know, finding the variety so very great.

Almost all insects, with the exception of dipterous larvæ, have their puncta like those of the Caterpillar, ranged along the side, and inosculating from branch to branch: often the puncta open along the sides; but in place of inosculating from branch to branch, all round one side, they inosculate across the belly, the one side communicating with the other. This is best observed in the small larva from which the Bee proceeds. And here it must be observed, that, as in insects, with the exception of dipterous, always the stigmata or breathing points correspond neatly with the folds or rings while it continues a larva, and with the segments or divisions of the body when it becomes a Fly; in the Bee-worm also the inosculations answer to the joint of the body.

Sometimes when an insect lives in water, it has only two puncta respiratoria: these puncta begin either in the snout or in the tail; they are the openings of two great air tubes which run down each side of the insect like two aortas, and the insect has means of rising to the surface, takes down a bubble of air along with it, and discharges a bubble of air before it rises again: of this nature are the air tubes of that Worm from which the Ephemeris proceeds. The two great air tubes are seen like two aortas running all along the body, and their minuter branches are seen ramifying beautifully upon the abdominal muscles and other parts. Many insects are aquatic when first they are hatched from the egg. They have little gills which serve them while they continue in the water, as, for example, the larva of the Ephemeris Fly. These little gills are fringed with micro-

scopic mamillæ, which communicate with the great tracheal branches; so that along with the gills they have the ordinary structure of air-tubes, and the day on which they emerge from the water, the gills shrink, and the air-tubes begin their function; and these changes succeed each other very rapidly in all insects, but most especially in the Ephemeris, which is destined to live but one day.

It is most of all singular, that in some insects the number of respiratory points, or puncta, changes according to the various conditions or stages of their existence. For example, a larva which crawls among the dust, since it must breathe less easily, has more puncta than when it has changed its state to that of a Fly, and has its puncta very freely exposed to the air: in the Rhinoceros Beetle the larva has more puncta respiratoria, and closer, because it crawls on the ground amidst mud or dust; they are less numerous in the Fly, as its air-holes are always more freely exposed; and when the Beetle is actually flying, those puncta, which were closed by the cases of the wings are fully opened; so that the insect breathes more freely, and perhaps its body is lightened, so that it flies more easily: it is also particular that in the full-grown Beetle, though the puncta be less in number, the lungs are enlarged, they both change their form and become more capacious; for the tubes are mere tracheæ or straight lines, with direct branches in the larva, but in the Beetle they are dilated from point to point into air-bags.

Insects in general are bred in eggs, transformed into larvæ, and of these the greater number assume the form of aureliæ; an aurelia is a Fly, small but full formed, with its legs drawn up, its wings plaited and folded, ready at all points to burst from the covering which surrounds it; for both in posture and in the membranes which surround it, it resembles a fœtus. In these three stages it still is supplied with air by air-tubes: they open by puncta respiratoria while it remains a larva; the same puncta still serve it while

it is wrapped up an aurelia or concealed Fly; when the Fly bursts out, the same puncta, the same tubes, which have served in its former stages, serve it still; only this is most curious, that when from a larva it proceeds to be a Fly, the skin which it rids itself of (by crawling out of it and pushing with its feet) carries off along with it many of the internal parts; the mouth, the anus, and especially all the respiratory tubes, lose an internal skin at the same time that the old skin or slough is pushed off from the outward surface of the body; and when the puncta are thus changed, they are left more open than before, and often their number is changed.

These are the various ways by which insects are supplied with air; and nothing can be more interesting than to observe the vast proportion of air which they draw in, which is certainly a provision for their living in places where oxygen cannot be plentifully supplied. And the fact is well known, that insects can live on air much less pure than what is necessary to breathing creatures, and that they exhaust the oxygen of the atmosphere much more completely than any other living creature. The variety in the manner of conducting the air to the system of insects, is changed, and suited, as I have observed, to their various ways of life, and to the various conditions and stages of their life; while they are Worms, when they are involved fœtuses, and when they have burst their shell, and are full grown. In short, Worms, Aureliæ, Flies, Beetles, Bees, and all forms of insects, have all of them their tracheæ by which they breathe a wonderfully large proportion of air.

There can be no mistake concerning the function of their air-tubes and of their circulation; it is ignorance or inattention only that can cause confusion; the heart of a Caterpillar, of a Snail, of the larvæ from which various Flies are produced, is seen distinctly through their transparent body, running down their back in form of a tube, sometimes slightly oval, sometimes having frequent dilatations, and throbbing,

though with less equable and distinct pulses than in the more perfect animals: or, perhaps, we should say rather exhibiting oscillations.

Nor can there be any mistake that it is air they breathe; for before we dissect an insect, we must kill it; the contortions of a live Caterpillar prevent all deliberate dissection, or even a view of the parts; we may poison the insect, as with turpentine or spirits: we commonly drown it; this is done by immersing it in a little tepid water. Nay, we find a thing which is at first inconceivable to be really true, that notwithstanding the inosculations of the air-tubes with each other, which seem to provide against all such effects, when we close up the stigmata of an insect one by one, the parts become in the same proportion paralytic; if we varnish over the stigmata of one side, that side becomes paralytic; if we varnish over the stigmata of both sides up to the last holes, the insect lives, but in a very languid condition, it survives in a kind of lethargic state for two days, without any pulsation in its heart; if we also stop the two highest holes, it dies.

Of all the examples of respiration, that which is reported by Spallanzani is what I most wonder at, and cannot but doubt. In acescent liquors, or the juices of animal bodies, animalcules are seen plainly with simple glasses, moving sometimes rapidly, sometimes slowly; but never hitherto has any author pretended to see their lungs or heart. Mr. Spallanzani says, "that these animalcules are elliptic bodies; that in the centre of each ellipsis he sees two stars, which are in constant alternate and regular motion, whether the creature rests or moves. Each star-like body has in its centre a small globe, and every three or four seconds the globules are blown up slowly to three or four times their natural size, and as slowly compressed again; and every time that the radii are inflated the central globule subsides. On one side of these star-like bodies there is an oval part, which is continually agitated with a trembling motion; he calls the star-

like bodies, lungs, and the oval body he thinks is the heart." Spallanzani surely has forgotten that he is speaking of lungs in an aquatic insect; if these star-like bodies have any such use, they must be gills.

These are the animalcules which Buffon called organic germs, and from which, as materials and pieces, he built up the animal body. But if all this be true, then the day is come which he little expected, when the organic particles, on the faith of which he built all his system of generation, are proved to be living and moving animalcules, voracious of food, devouring each other, breathing air, and having a visible pulsating heart; animalcules deposited from the atmosphere, and generating like other insects of their kind.

Thus we are convinced of the importance of respiration, and the absorption of air in all living creatures, from Man even to the meanest reptile; and not least needful in the last and lower order, which receive in proportion a fuller supply of air than fishes, amphibia, or Man.

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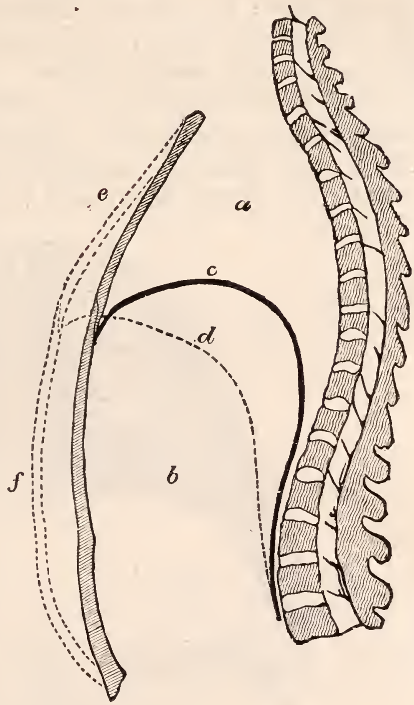
## OF THE MOTIONS OF THE THORAX, AND OF RESPIRATION IN MAN.

We have understood by our studies of the skeleton, and of the muscular system, now admirably adapted, the thorax is to dilatation and contraction; and how the muscles act upon the bony and cartilaginous apparatus for this purpose. We have seen also that the cartilages are added to the ribs and sternum, to give them elasticity, and consequently strength, or at least a principle of resistance. This elasticity of the texture of the thorax serves another purpose; it preserves the chest in a middle condition, betwixt its utmost state of contraction and of dilatation, and tends to preserve life.

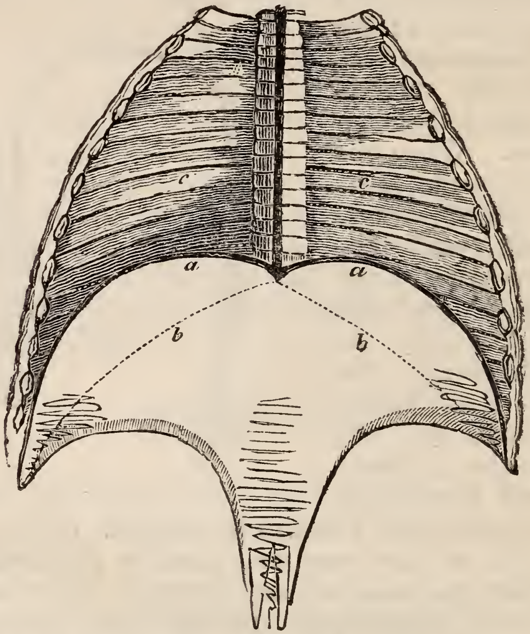
Let us now understand what takes place in the drawing of the breath.




This figure represents a section of the body—(*a*) the thorax—(*b*) the abdomen. These two cavities are divided by the diaphragm which is represented by the arched line (*c*); for the diaphragm assumes this arched form especially in expiration. When the effort is made to inspire, the diaphragm descends, and then its state may be represented by the dotted line (*d*). As the diaphragm descends, it of course compresses the viscera in the abdomen (*b*), and this pushes out the abdominal muscles in the form of the dotted line (*f*); at the same time that the diaphragm and the abdominal muscles have changed their condition, the ribs are expanding, and the breast-bone (*e*) is rising, so that the thorax is enlarging in all its diameters. This being the act of inspiration, we easily understand expiration to be the return of these parts to their original condition, *i. e.* the descent of (*e*); the falling in of (*f*); and the rising of (*d*) to (*c*.)

Let us now take a front view of the thorax, so that we may have our notions of the action confirmed and corrected. We have the cavities of the thorax divided by a dotted line; and the floor of these cavities formed by the arch of the diaphragm

(*aa*). When the diaphragm contracts and descends, it can not uniformly descend as represented in the lateral plan; for we have understood that it is tied up by the mediastinum. The perpendicular dark line represents the mediastinum. Thus the arch (*aa*) instead of descending in a single arch, acts on its lateral parts principally, and assumes the form (*bb*). As it was formerly explained, it acts on the lungs more than on the heart and vessels.




The student who has attended to the anatomy and relations of the lungs, must perceive that the rising and falling of the chest, and the propulsion upwards of the diaphragm (by the abdominal muscles,) and its descent, must influence the lungs, alternately drawing the atmospheric air into them and expelling it; and thus the act of respiration is performed, the lungs being passive. He must perceive that by this mechanism, in which the whole muscles of the neck, chest, and abdomen, and back are concerned, there

is a continual exercise, and an incessant motion or agitation of all the viscera. No doubt this is conducive to their proper function and to health. He will, no doubt, also observe, that this extensive apparatus of bones, cartilages, and muscles, serve other purposes than mere breathing, that they assist the circulation of the blood, that they are agitated in speaking, coughing, laughing, crying, smelling, vomiting, the expulsion of the fœces, &c. He must perceive this importance in the economy, and must surely be desirous of knowing how they are combined and animated—for which see the nervous system. The action of the diaphragm on the circulating vessels is a subject which, for the present, I must reserve.

## OF THE PECULIARITIES IN THE CIRCULATION OF THE FŒTUS.

The peculiarities of the fœtus relate principally to the circulation of the blood, and are such chiefly as fulfil the circulation without any need of its passing through the lungs, enabling the fœtus to live without that function in its mother's womb.

The system of the fœtus is attached to the maternal system, through the placenta, as we shall afterwards find. The placenta is a sort of cake, consisting of numerous convoluted vessels, belonging in part to the fœtus, in part to the mother, and fixed to the interior surface of the uterus. The umbilical cord, or funis, consists of one large vein, and two arteries: and these vessels go out from the umbilicus of the fœtus to the placenta, and circulate the blood in that body, by which, of consequence, the blood of the fœtus is exposed in vessels of indescribable minuteness, to the corresponding vessels of the maternal system.

We are assured that the blood which comes to

the fœtus through the umbilical vein is pure, or of greater value than that which the fœtus returns to the mother's system. Either this blood is restored to all its properties merely by passing through the mother's system, and what is thus drained off from the extremities of the mother's system is more than sufficient for the life of the child; or, without such direct communication, the placenta performs to the fœtus a function equivalent to that of the lungs.

The blood returning from the placenta to the fœtus, by the great vein, is of the arterial colour, as we have said, and fit for the uses of the fœtal body, and capable of nourishing it. The umbilical vein entering the body of the fœtus, by the umbilicus, runs, directed by the broad ligament of the liver, under that viscus. Here, within the liver, it forms a large and direct inosculation with the vena portæ. To comprehend this subject at all, we must so far anticipate, as to say, that the vena portæ is a vein which collects the blood of the stomach, spleen, and intestines, and carries it into the liver.

The blood thus, as it were, conveyed by the umbilical vein into the system, does not circulate there, but finds a direct passage into the heart. This passage is called DUCTUS VENOSUS, it runs direct from the extremity of the umbilical vein into the CAVA ASCENDENS, and consequently it conveys its blood into the right auricle of the heart.

This blood does not pass through the circulation of the lungs; perhaps it ought not to pass; for there being no respiration, no air admitted to the lungs, the blood might rather be contaminated; perhaps it cannot pass, the lungs never having been expanded with air: but, however that be, there is a side passage for conveying it from the right to the left side of the heart clear of the lungs. For this use is the FORAMEN OVALE, which is an opening of no inconsiderable size betwixt the right and left auricle

of the heart; its area is as large as that of the vena cava; and it is sufficient to convey the blood freely from right to left.

The DUCTUS ARTERIOSUS serves quite another purpose; for though the circulation of the aorta is well maintained in the adult body by the force of one ventricle only, yet in the fœtus one ventricle will not suffice. In the fœtus the heart must push its blood not only through that system of vessels which is within the body, but also it must push it onwards through a second circle of vessels, viz. those of the placenta; for we might be tempted to say that the iliac arteries do not descend into the thigh and pelvis of the fœtus, but the iliac artery itself, with little diminution, (very small branches only being given downwards into the pelvis and thigh,) turns upwards along the side of the bladder; and these two arteries going out from the navel, form with the great vein the umbilical cord; and the heart of the fœtus has to give life and action not only to the internal system of the body of the fœtus, but to these two arteries, which run out to the distance nearly of three feet along the umbilical cord, and which make wonderful convolutions in the placenta, and terminate with extreme minuteness, as we have said, in the extremities of the umbilical vein. It is this which occasions the necessity of the ductus arteriosus, which is merely a union or inosculation of the pulmonic artery with the aorta. This union is formed by a great branch of the pulmonic artery in the fœtus, joining the aorta below its curve. This great branch (for it is greater than the two branches which go to the lungs,) is named the DUCTUS ARTERIOSUS, and may be defined an inosculation betwixt the pulmonic artery and the aorta, so very large, that it gives the aorta of the fœtus twice its natural size and proportion, and enables the blood of that artery to receive the full force of both ventricles.

The contaminated or venous blood of the fœtus must be returned to the mother, or at least to the

placenta; for which purpose the two iliac arteries are reflected along the side of the bladder as I have just explained. I say the iliac arteries without reserve, because the hypogastric and femoral arteries, that is, the arteries of the pelvis and thigh, though they are the largest branches of all the body in the adult, are in the fœtus extremely small; and thence that smallness of the lower extremities compared with the largeness of the head, which characterizes the child, and which it takes years to redress.

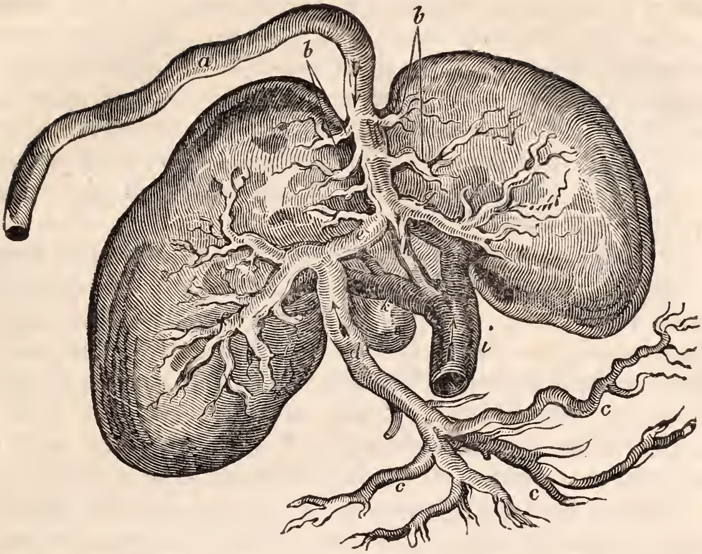
Thus have I defined these parts and their uses, in order that their strict anatomy may be the more easily explained; and the part first mentioned, viz. the ductus venosus, is the part the most difficult to be understood, and never without the help of a plan. In the plan I have endeavoured to elucidate these points.

First, The mere anatomy, connections, and inosculations of the vessels; showing how the umbilical vein brings in the blood of the mother; how that vein spreads in the liver, and feeds all its left side with blood; and how the ductus venosus carries part of that blood away from the circulation of the liver, conducting it directly onwards to the right side of the heart.

Secondly, I have endeavoured to explain what parts of the liver each branch supplies, and how these vessels lie in the liver of a new-born child.

The blood from the maternal system transmitted through the placenta, and oxydated, or having undergone some change equivalent to what takes place in the lungs of the adult, comes down along the umbilical vein: — the vein enters by the navel, adheres to the inner surface of the abdomen, enters into the liver at the top of that great transverse cleft which divides the liver into two lobes; and after entering the liver, it begins, as if it were the regular and peculiar vessel of the liver, to distribute branches through its substance from right to left.

In the Plan.—(*a*) shows the umbilical vein, (*b*)




branches given to the substance of the liver, (*c. c. c.*) three great veins from the spleen, stomach, and intestines, which run together, and forms (*d*) the VENA PORTÆ. (*e*) The cylinder of the portæ being its great right branch where it lies in the transverse fissure ;—(*f*) the great right branch of the vena portæ in the liver. Next comes (*h*) the ductus venosus, whose office is important, but the size of which is not quite what we should suppose. It comes off direct from the umbilical vein (*a*) ; its course is short, and a little curved ; it joins at (*i*) the largest of the hepatic veins, *i. e.* of those great veins which return the blood from the liver, and along with it goes directly into the right auricle of the heart ; (*i*) the cava abdominalis ; (*k k*) the cavæ hepaticæ. This, perhaps, might suffice as a description of the ductus venosus ; but it is convenient, and will make a clear subject, to finish that circulation of which this ductus venosus is one of the chief difficulties.

The ductus venosus (*h*) I consider as the end of the umbilical vein (*a*), for here its circulation ends ;

or, if it sends blood into the right branch of the vena portæ (*k*), its proportion is but small. But the VENA PORTÆ, (which is just the collection of all the abdominal veins (*c. c. c.*) into one trunk,—of the splenic vein, of the mesenteric vein, of the hemorrhoidal vein, *i. e.* the vein from the pelvis)—the vena portæ (*d*), I say, composed of all these veins, is the true vein of the liver.

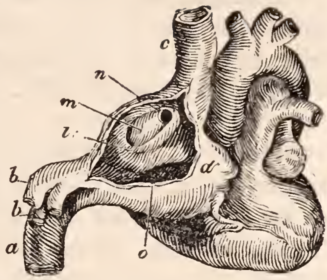
The branches of the vena portæ are gathered into a trunk, that trunk enters the liver; it divides into two great transverse branches, the one serving the right side of the liver and the other the left; but in the fœtus this left branch is not known as the limb or left branch of the vena portæ, but looks rather like the right branch of the umbilical vein; indeed it is named so by Mr. Bertin.

Those peculiar veins which we find in the fœtus, are accommodations for its circulation, are ranked among the peculiarities of the fœtus, and are, when the child is born, obliterated by a new circulation; and what is very curious, by a circulation which goes through the same vessels in a retrograde course.

The liver of the fœtus has blood circulating in two directions; the right side of the liver is filled from the vena portæ, the left side by the umbilical vein. The liver of the fœtus having two veins has a large quantity of blood, a growth larger than that of any of the viscera; and indeed the liver alone seems to fill all the upper region of the abdomen. This is changed when the child is born; the umbilical circulation is cut off, and the liver of the child ceases to grow but in proportion to the other parts.

But what is most extraordinary, is this, that the proper function of the liver is not performed, while the fœtal circulation continues, and it is only when the blood of the umbilical vein is cut off by the tying of the cord, and when the venous blood comes slowly up from the vein of the membranous viscera of the abdomen, to fill this extensive system, that the true and stimulating bile is formed in the liver.

## FORAMEN OVALE.




($a$) The ascending cava, with its hepatic branches ($b$ $b$),—($c$) the descending cava,—($d$) the right auricle, where it lies against the roots of the aorta and of the pulmonic artery,—($i$) the isthmus Veussenii, as it is called, or circle which surrounds the oval hole,—($m$) the valve of the foramen ovale,—($n$) a small opening, which we always find towards its upper part,—($o$) the opening towards the ventricle. This plan is intended chiefly for showing the true place of the foramen ovale; its anatomy and just form is better represented in the true drawing which ends this subject.

The foramen ovale, which we have mentioned as one of the chief peculiarities of the fœtus, is a hole of no inconsiderable size, transmitting the blood freely from the right to the left side of the heart. Its use is obvious, even from a general view of the system; and when we look more closely into its mechanism, its uses are completely explained. Its valve being placed on the side of the left auricle, perfectly settles (and that by the only authentic proof) the course of its blood; and, satisfied with the description which I am now to give, I decline all disputes about the nature of this opening, or its valve. This is a subject which disputes may perplex, but cannot explain. Another reason which I have for declining such controversies is this: It is an easy matter to impose upon a whole academy, easier by far than upon one ingenious man; and thus it came to pass that in the French Academy each theorist brought dissections of the heart, and foramen ovale suited to his own doctrines; each, when convenient, changed his ground a little, and brought new dissections; and thus valves and auricles, fœtal and adult hearts, double cats and human monsters, made their annual exhibitions in the halls of the French Academy: the Society never sickened nor tired, and the raree-show lasted exactly one hundred years.

What kind of doctrines were current at such a time it is almost superfluous to explain ; yet I think it not amiss to remark two examples, of obduracy on the one hand, and of ingenuity on the other, in two of the greatest men. Mr. Mery had conceived notions about the circulation of blood in the fœtus, which can hardly be explained* ; but it was one point essential to his doctrine, that the blood in the fœtus moved directly from the left auricle to the right. He was forced to deny that the foramen ovale had a valve ; and this doctrine he continued, with many quirks and tricks, to maintain to his dying day. Mr. Winslow agreed with Mery ; he said, that the foramen ovale had no valve ; that though it had a membrane, that membrane performed nothing of the office of a valve ; that the blood passed freely from right to left, or from left to right, as occasion required ; that thus the two auricles were as one. He forgot for a time that there is but little circulation in the fœtal lungs ; that the right auricle is filled with all the blood of the body, while the left is filled very sparingly by the pulmonic veins. From these data it is plain, that the balance must always be in favour of the right auricle ; that it always must be more full of blood ; that without some valve the blood must rush with a continual pressure from right to left ; while, again, the place of the valve is itself a demonstration that the blood cannot pass from left to right. Winslow, when he some years after perceived that he had spoken idly upon this subject, left Mr. Mery among his foolish arguments and dissections, and retracted all that he had written, with a manliness of spirit which deserves to be recorded.

The foramen ovale is not strictly oval, but is rather

* All that can be done towards the explaining it in one word is this : He "fancied that the right cavity of the heart was so large and the left so small, that always the left side was obliged to disgorge again upon the right side ; and this was the meaning of the blood rushing through the foramen ovale from the left side to the right."

round. In the plan it appears oval, because there I have endeavoured to represent the condition of the vessels when the heart is dilated and the vessels full; but when we lay it out for demonstration or for drawing, it appears, as in the drawing, of a rounded shape.

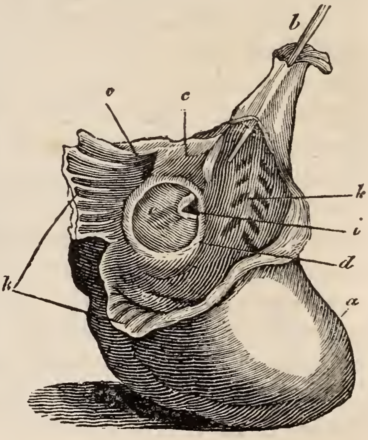
The oval hole is in the partition betwixt the two auricles at its very backmost point; for, in fact, the auricles touch each other only behind; at their fore-part they are separated by the roots of the aorta and pulmonic artery, as may be seen in any of the plans. We look, then, for the foramen ovale at the very backmost part of the right auricle; or rather it is placed so high in the auricle as to seem to belong rather to the root of the cava descendens. A ring rises round the borders of the hole, very prominent. This was named ISTHMUS VEUSSENII; but this conceited name of isthmus, Veussens gave it, is quite unintelligible, and it must be changed for that of the CIRCULUS FORAMINIS OVALIS, the ring or circle of the oval hole. This circle is thick at its edges; very strongly muscular, like the musculi pectinati of the auricle; in so much that authors of some character have thought this a sphincter for the oval hole. There is no doubt a kind of decussation of the fibres at each end of the oval hole; so that these fibres, forming a sort of pillar on each side or edge of the foramen, the name of Pillars of the Ring, or COLUMNÆ FORAMINIS OVALIS, is less exceptionable; though these pillars, or any thing deserving such a name, will not be easily found by one beginning anatomy.

The valve of the oval hole lies entirely on the left side, as the round edges of the right side may demonstrate. By taking the blunt probe, we find we can lift it towards the left side; but being pushed towards the right side, it rises into a sort of bag, and opposes the probe. The valve is perfectly transparent; it seems delicate, like all the other membranous valves, but is really strong. There is often left,

after the closing of the valve, a small opening at its upper part. The valve closes soon after birth: the hole is so large, that this membrane forms a very large share of the partition betwixt the auricles; its transparency is such, compared with the rest of the walls, that it is as distinct in a boy, or in an adult, as in a fœtus.

This is the anatomy of the oval hole, and of its valve; and this proves, and any one who examines it will entirely be convinced, that the blood of the fœtus passes through it from right to left.

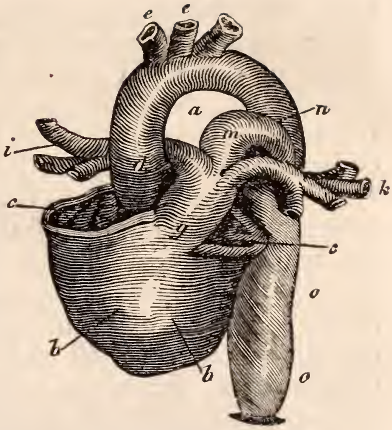
This heart of a fœtus had all its parts cut away, except the ventricles (*a*) — the vena cava, with a blow-pipe in it (*b*)—and the wall or partition betwixt the auricles (*c c*), which is here unfolded to show the foramen ovale. The musculi pectinati, or muscular fibres of the auricle, are well seen at (*k k*)—(*d*) is the annulus foraminis ovalis, — (*e*) is the valve itself,—(*i*) is the small opening in the upper part of the valve, where the valve falls slack, and ready to open.




DUCTUS ARTERIOSUS.

The ductus arteriosus I have defined a great inosculation betwixt the pulmonic artery and the aorta; not for the purpose of conveying away that blood which should pass through the lungs, but for giving to the blood of the aorta the propelling power of both ventricles; and how well it is able to perform this office, will be easily seen from the drawing on the margin.

The pulmonic artery of the adult divides, as has been marked in all my former plans, into two great arteries, one going to the right side, another to the left; but in the fœtus there arises a middle branch




This sketch is taken from a little preparation made on purpose, where a quill was thrust in so strongly betwixt the ductus arteriosus and aorta, as to separate them unnaturally, and leave a space (*a*) betwixt them. (*b b*) Marks the two ventricles —(*c c*) the place from which the two auricles were cut away to make every thing clear,—(*d*) the root of the aorta, known by (*e e*) its carotids,—(*g*) is the root of the pulmonic artery, (*i*) the right and (*k*) the left pulmonic arteries,—(*m*) the ductus arteriosus, or middle branch, running into the aorta,—(*n*) the place where they join,—(*o o*) the aorta increased in size by this addition.

*N. B.* This heart is but a very little under the natural size in a new-born child.

betwixt these two. It is larger than both put together; it is in the middle, and so comes most directly from the heart; it goes in a straight line towards the aorta, and joins with it immediately below the arch. This is the ductus arteriosus, the centre branch of the three branches into which the pulmonic artery of the fœtus is divided. It is bigger than the aorta in the fœtus; it gives the full force of the right ventricle to the blood of the aorta, in addition to that of the left. In the adult it is so thoroughly obliterated, that by the most careful dissection we can show no other vestige of it than a cord-like adhesion of the aorta and pulmonic artery.*

These, then, are the chief peculiarities of the circulation in the fœtus †: but the conclusions which have been drawn from this mechanism are, as I sus-

* For the other peculiarities of the fœtus, see the description of the intestines, of the kidney, of the thymus, and of the membrana pupilaris of the eye.

† The umbilical arteries must be explained in another place.

pect, very far wrong. But this I can in no shape prove, till I shall have first represented the real condition of the fœtal heart. First, then, let it be observed, that every drop of blood which comes into the system is, either by the powers of the placenta, or by communion with the mother's system, oxydated blood. — One part of this blood, indeed, passes through the circulation of the liver before it reaches the heart, while another passes more directly through the ductus venosus; but both are mixed, and the blood is all of one quality when it arrives at the auricle, in order to fill the heart, and to begin its course round the body. Now, since the blood is all of one quality, Nature could have no cause for dividing such blood into two portions; one to pass through the lungs, the other to pass over the body. She could have no motive for employing, as in the adult, two hearts. The design of Nature plainly is, to prepare a double heart, and kept it in reserve for the circulation of the adult, but to use it as a single heart in the fœtus. And see how simply this is accomplished. The two auricles communicate so freely by the foramen ovale, that they are as one: the two ventricles both deliver their blood into one vessel, the aorta; and they are also as one. The blood arrives by the cavæ, fills the right auricle, and in the same moment fills, through the foramen ovale, the left auricle; so that the auricles are as one, and filled by one stroke; the two auricles act at once, and so the ventricles also are filled by one stroke; the aorta receives the blood of both ventricles at one stroke. So that, in the strictest sense of the word, the fœtus has but one single heart, the heart of the body (the function of the lungs being performed by the placenta, far from its proper system); and when the function of its own lungs begins, then Nature, by the simplest of all mechanisms, divides the two hearts, that they may perform each its peculiar function. First, the flow of blood into the lungs deprives the ductus arteriosus of blood; and, secondly, this flow

of blood coming round to the left auricle of the heart restores the balance, presses down the valve of the foramen ovale, and makes the partition betwixt the auricle entire. In short, while the oval hole and ductus arteriosus are open, it is a single heart; and when they close, as they do the moment the child is born, it becomes the double or perfect heart.

Now the mistake which all physiologists have fallen into is this: — They have not observed that no creature can live with a single heart, which has the oxydation of its blood performed by lungs. A fish lives by a single heart, because its blood is oxydated by gills, not by lungs: insects live with a single heart, as their lungs, or the branches of their lungs, are distributed like arteries over all their body: the fœtus can live with a single heart, because its blood is oxydated by the placenta. And that this idea may make a more determined impression, it will be good to prove, that the function of the placenta actually is equivalent to the function of the lungs; and that it is the placenta itself that produces this change upon the blood, I am the rather inclined to believe, because we see the veins and arteries of the chick spreading over the membranes of the egg, and we can observe the artery sending dark-coloured blood into these membranes, while the vein brings back florid or oxydated blood.

If, during child-labour, the umbilical cord falls down before the head of the child, at first it is not pressed but beats strongly, and the fœtus is felt struggling in the womb; but when, after a few pains, the head descends into the pelvis, the cord is pressed betwixt the head and pelvis, the pulse falters, ceases; the child ceases to stir in the womb; and if not born in a few minutes is irrecoverably dead, and is black in the face like one strangled or drowned. When a child comes with its feet or other parts of the body first, the head being last delivered, is difficultly delivered; the accoucheur struggles long in bringing out the head; the umbilical cord is compressed all

the while, betwixt the child's head and the brim of the pelvis, and the child dies. Neither the ductus arteriosus, nor the oval hole can save the child, for it dies because it is deprived of the function of the placenta, which is the fœtal lungs; and this is the cause why it appears, when born, like one suffocated or drowned.

When the child is born, the nurse lays it on her knee, the cord being uncut, you will observe that the one function declines exactly as the other strengthens. That if the child do not breathe freely, the cord will continue to beat steadily, the placenta still attached to the uterus continuing to perform the function of the lungs: that when the child begins to cry freely the pulse of the cord and the function of the placenta cease at once. If the child breathe freely, but yet do not cry, and you tie the cord, it is instantly forced to cry for a fuller breath; and if a rash person tie the cord prematurely, when the child neither cries nor breathes, he cuts off the function of the placenta before the function of the lungs is established, and often the child is lost: this, in the hurry and officiousness of ignorant women happens every day. If even after two days the child's breathing be much interrupted by coughing, crying, or any spasmodic affection of the lungs, Nature seeks again the function of the placenta, and the pulse returns into the cord so as to raise it from the belly of the child. These things prove what the best physiologists have sometimes forgotten, that the fœtus has, in the function of the placenta, something equivalent to the function of the lungs.

One great mistake then runs through the whole of physiology. It has been universally believed that the free and easy transmission of the blood was the chief use of the lungs, as if they had acted like fanners to flap on the blood from the right to the left side of the heart. They affirmed, that either continued distension or continued collapse, hindered the progress of the blood; and they also believed univer-

sally, that if but the ductus arteriosus or foramen ovale, or any thing, in short, were left open to let the blood pass, that person may live in spite of hanging, drowning, or suffocation of any kind.

This will be found to be the most perfect of all absurdities; and to allege such a thing against authors, requires some kind of proof; it will suffice, if I prove it against a few of the most eminent. So much were the older authors wedded to this misapprehension of the dilatation of the lungs being useful only by driving forwards the blood, that, in the Parisian dissections, we find the following experiment made on purpose to prove the fact. "We have also made another experiment (say the Parisian dissectors) to know more distinctly the necessity of the motion of the lungs for the entire circulation of the blood. An injection being made by the right ventricle of the heart into the artery of the lungs of a dead dog, it happens, that if one continue to make the lungs rise and sink alternately by means of bellows put into his trachea, the liquor pushed into the artery does easily pass and go through the vein into the left auricle; but when one ceases to blow, it passes not but with a great deal of difficulty," (page 262.) — Which doctrine is dilated into its full absurdity in the next paragraph. "Having viewed the difference of structure, in a tortoise and in a dog, it is easy to give some probable reason of the phenomena of these experiments; and the reason is, that it is necessary that these vessels shall be dilated for the receiving of the blood of the right ventricle of the heart, and that they may be afterwards compressed in expiration to press out the blood, and make it pass into the left ventricle." Swammerdam indeed says, concerning the Frog's lungs, that an artery goes over them, which has no other purpose but to nourish the lungs; and that it is of the nature of those called bronchial arteries in Man. But the College of Dissectors have plunged still deeper into this remarkable blunder; for they say, (page 261.) in speaking of the

lungs of Newts, Frogs, and other creatures, which I have represented as having a pulmonic artery extremely small in proportion to their system, " that in such creatures the lungs have merely that quantity of blood passing through their substance which is necessary for their own particular nourishment;" which is saying in the plainest terms, that they have lungs (only, I suppose that they may be like other creatures); but their lungs are of no manner of use, except to nourish themselves.

One should have thought that the folly of this opinion would have appeared more striking in proportion to the earnestness of these arguments, and that no subsequent author would have deigned to honour such an opinion so far even as to notice it: but the celebrated Haller not only adopts this notion very fully, but enriches it with further explanations, saying, " that the vessels are all, during the contraction of the lungs, forced into numerous angles and joint-like folds; that the angles are made even, and the passages of the blood more direct upon the expansion of the lungs." As if the lungs, folded and closed upon each other like the wings of a Butterfly or Beetle. * Santorini also represents the vessels of the lungs as thus collapsed, plaited, and folded a thousand various ways, "assaissé et replié de mille manieres differentes," &c. " One effect of expiration (says Haller) is so to compress all the arteries of the lungs, that they cannot receive the blood from the ventricle of the heart so freely as they are wont to do. †

" It must seem very strange for me, after saying that inflating the lungs restores an animal after apparent death, and recovers the drowned, to affirm

* " Præterea, in vivo animali, cujus cor contrahitur, et in arterias pulmonales sanguinem data vi emittit, omnino nunc sanguis in eas arterias facilius, atque adeo celerius irrumpit, postquam deletus retardatricibus plicis, recta nunc sunt."

† " Verum alter effectus expirationis est utique pulmonis arterias ita comprimere, ut ne pari facilitate sanguinem a suo cordis ventriculo recipiant."

that long continued respiration is fatal * : and yet we need not look long for the cause of this ; for during this long continued respiration, much blood must be gathered in the lungs, but none can get out. †" Nothing is attributed, in his explanation, to the want of air, but all is attributed to the obstruction of the blood : yet if this were all, Amphibia would need no lungs, fishes would need no gills, insects could need no air-tubes ; for none of these assist the motions of the heart. Monro, who puts Haller to rights in every thing else, follows him in this. " In all amphibious animals, therefore," says Monro, " every part of the body may receive a considerable portion of blood, although the respiration and free passage of the blood through their lungs be interrupted, (p. 21.) &c." And the celebrated Blumenbach, the man most admired on the continent for his Physiology, says, at p. 80., " Post extremam respirationem redeunti per venas cavas sanguini via sueta in pulmones nunc collapsos præcludatur." ‡

Thus it has been the opinion down to the present day, that the collapse or over distension of the lungs are both equally opposite to the easy passage of the blood : but instead of going round about the matter

* " Paradoxum videri possit, ab inspiratione sanguinis in pulmonem commeatum expediri : inflato etiam aëre, quod genus est magnæ inspirationis, animalia moribunda reviviscere, et sanguinis per pulmones iter revocari : et tamen hanc eandem, adeo faventem sanguinis per pulmonem motui inspirationem, sola paulo diuturniori continuatione, anxietatem primo incredibilem facere, deinde, si vel voluntatis violento imperio tamen aer in pulmone retineatur, vel ab alia causa intra pulmonem copiosior servetur, denique sanissimum et fortissimum hominem subito interire."

† " Hujus nunc anxietatis et suffocationis, et denique mortis causam non est arduum invenire. Adparet enim, ab inspiratione diutius continuata, sanguinem in pulmonem quidem advenire, et congeri, exitum vero ex pulmone non invenire."

‡ Mr. Keate, one of the latest writers on the recovery of drowned persons, has the same notion. " We inflate and empty the lungs (says he), in order by their expansion and contraction to FORCE the blood across from the right to the left side of the heart."— And he expresses himself as perfectly indifferent what kind of air be used, foul or pure is all one.

as some lesser authors have done, I like rather the manner of the Reverend Dr. Hales, who says, plumply, "that suffocation consists in the falling flat of the lungs." (p. 271.)

Now, the condition of the human lungs is quite opposite to all this; and also (in respect of distension) is less different from the lungs of reptiles than it is easy for any one bred up in the old doctrines to conceive.

In expiration the lungs do not collapse in any sensible degree. Let us take for our data the common calculations concerning the quantity of air in the lungs, and let us see what they will do towards proving this opinion. The lungs are supposed to contain at the time of their utmost fulness about 220 cubic inches of air. When we continue breathing in a natural and easy way, we draw in and expel alternately about 40 cubic inches of air; but when we choose to force respiration, we find that we can expel without danger or harm 70 inches more; we can expel 110 inches of air, leaving only 110 inches remaining in the lungs. Now, let us for a moment, observe how little danger or distress it occasions when a forced respiration is made — such as is used in coughing, laughing, speaking, crying, expelling the child, urine, or fæces, bracing up the body for the lifting of heavy weights, or other violent occasions, for which such forced respirations are by nature reserved. Let us notice how much forced respiration exceeds the ordinary respiration, and how small a proportion the quantity of an ordinary breathing, viz. 40 bears to 220, the whole quantity of air within the lungs. Reflecting thus what large inspirations of air we may take, and how very little we do take, we begin to perceive how gentle the motion of the lungs must be.

There remains always within the lungs a great mass of air, which I will call the permanent dilatation of the lungs, which, from the first movements of the child, from the hour of birth till death, and even

after death, must remain in the lungs. This mass, equal to 220, cannot be entirely breathed out; even the utmost force of respiration expels but the half: this is never done but on extraordinary and most urgent occasions, which do indeed disturb the circulation; as coughing, laughing, crying, or running do. And here we may stop an instant to admire one happy effect of this provision; if in ordinary breathing we had emptied the lungs, we should have been continually subject to suffocation; whereas when any thing irritates to cause coughing, we can by extraordinary effort expel an additional quantity of air, and, by coughing or sneezing, remove the cause of irritation. If there had not been at all times of ordinary breathing a large portion of air in the lungs, we must have inspired, and have drawn in the irritating body instead of expelling it. But this great mass of air in the lungs is seldom so moved; it is regularly and gently agitated by the change of 40 parts of the 220, which we expire and draw in again at each breath; we do not empty and fill the lungs at each breath: there is, on the contrary, a permanent expansion of the lungs, and a mass of air always in them; there is along with this a gentle and regular agitation; and there is changed at each respiration a small proportion of this mass of air. Our lungs are little different (in respect of distension) from those of Amphibia: for their lungs also, as I have described in the Frog, are permanently expanded, and at each respiration a little dilated and contracted; the air a little changed, a little moved, a little renewed; the change is in both cases placid and gentle, and hardly to be perceived.

With these opinions concerning the state of our lungs, nothing can appear to me more coarse than the notion of their being entirely filled and emptied at each breath; nothing more ignorant than the supposing them to fall flat, as Hales expresses it, so as to hinder the motion of the blood: and the grossness of this opinion appears in its true light when I put down this last proof, viz. that for each act of respir-

ation there are four pulses of the artery, or four strokes of the heart. Is it not plain, then, to the meanest apprehension, that if the blood moves twice through the lungs in expiration, and twice during inspiration; or, in other words, if there be four strokes of the artery for each respiration, and if each of the four pulses be equally strong, that the blood passes through the lungs in all states and conditions with equal ease? *

It is also universally believed, and it is indeed a most legitimate conclusion, from this doctrine of the collapse of the lungs hindering the passage of the blood, that if but the foramen ovale or any passage be left open to let through the blood, that person will live without breathing.

It has been affirmed, that the Seal, the Beaver, the Otter, have the foramen ovale open. In the Seal, the Parisian dissectors found the oval hole open as in a child; but when they came to the foramen ovale of the Beaver and Otter, they found them, and sore against their will, quite close. In their disappointment they could have said any thing; but all that they thought prudent to say was, that the Beaver had not been in the water for a long while, not even to refresh himself †, and the Otter had been close penned up in his hut at Versailles; and so the foramen ovale had closed in these poor beasts quite close; and behold they were no longer Otters and Beavers, but little better than dogs.‡ Although

* Their old and favourite experiment, so often repeated by Hooke, Croone, and others, before our Royal Society, viz. of blowing up the lungs of a dog, and then compressing them, is good for nothing: for there the thorax is cut clean away; the permanent distension of the lungs is entirely lost; and then, no doubt, there is such a collapse of the lungs, as may, or rather must, hinder respiration; for the lungs are alternately distended to the greatest degree, and then emptied as completely.

† The Beaver sits in his hut just up to the hips in the water, and builds his hut so that he may sit just up to the hips.

‡ "Cette ouverture, qu'on appelle le trou ovalaire dans le fœtus, fait l'anastomose par le moyen de laquelle le sang va de la veine

Haller * declares that he had found the foramen ovale open in a man who was hanged; though Rœderer, Cheselden, and many creditable witnesses, have testified the same; still there has gone along with these confused doctrines about the foramen ovale a kind of dream, (like that concerning the transfusion of the blood,) that if but the foramen ovale could be preserved open, Man even might be made an amphibious creature. At first this notion began to peep through the mists of this doctrine; and you might find an author, when he had dissected a person with the foramen ovale open, insinuating by oblique notions, what a vast pity it was that the man had not known, during his life, how kind nature had been to him, and what a perfect diver he was! while another says plainly, on a like occasion, "What a pity it was that this child did not live!" we should have seen almost an amphibious human animal, at least a most notable diver.† On this slender ground they told the most wonderful tales, among which Pechlinus's story of the Tronningholm gardener is one of the prettiest. "The ice having broken, the gardener, in trying to help out some others, as frequently happens, slipt in himself into a place full eighteen yards deep. There he no sooner touched the bottom, than he felt as if you had clapt a plaster over his mouth; his feet stuck fast, his body became rigid, and he stood there as stiff as a stake, with no one of his senses about him, except only that he

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cave dans l'aorte sans passer au travers du poumon; et c'est apparemment pour une même usage que ce passage se trouve dans le veau marin que dans le fœtus, à cause du besoin que l'un et l'autre ont de se passer de le respiration, sçavoir le veau marin pendant qu'il est plongé dans l'eau, et le fœtus pendant qu'il est dans le ventre de sa mere, où il est certain que les anastamoses servent a décharger le poumon de l'abondance du sang qui le suffoqueroit."—Vid. *Acad. des Sciences,* Anno 1699, page 149.

* Vol. II. part ii. p. 11.

† Mr. Chemineau says, "On auroit vue avec étonnement un Homme presque amphibie comme la Tortuë." Page 38.

thought he heard all the while the Stockholm bells ringing most pleasantly; and there he stood for sixteen hours, the folks seeking him up and down, and wondering where he could be: at last having found him, they hooked him out with a pole; and after much warming, and rubbing, and working, and giving him hot drinks, they got his blood to circulate, and brought him to life again. He had sense enough, however, he said, to feel their hook; and, indeed, they had angled so ill, that his head was all bruised, and he had terrible headachs: but, however, the Queen-Mother gave him a good pension, and he was sixty-five years of age when Pechlinus wrote." This is one of the many stories of men preserved by the foramen ovale not having been shut. At first, I say, this opinion began to peep out in hints and reflections; then it strengthened into wonderful tales of people being recovered who had been under the water six days; till at last a great genius undertook to make water-whelps upon a new principle, viz. with the foramen ovale open. This great genius was the Count de Buffon, and a very celebrated author of our own country, Dr. Beddoes, forgetting, perhaps, how successful Buffon is, tells us, (page 41.) that "by frequent immersion in water the association betwixt the heart and lungs might perhaps be dissolved, and an animal be inured to live commodiously under water for any time."

Let us move just a step backwards in this new trade of making amphibious animals, and observe how the celebrated Buffon succeeded. "I procured a pregnant bitch (says Buffon) of the large greyhound kind: and when just about to litter, I fixed her so in a bucket full of warm water that her hinder parts were entirely covered. In this situation she brought forth three puppies; which, after being disengaged from their membranes, were immersed in a fluid nearly of an equal temperature with that of the amnios. After assisting the mother, and washing the puppies in this water, I suddenly removed them into a pail of warm

milk, without allowing them time to respire. I put them into the milk in preference to the water, that they might have an opportunity of taking some food, if they found a desire for it. I kept them immersed in the milk for more than half an hour; and when taken out of it, all the three were alive. They began to breathe, and they discharged a quantity of fluid matter by the mouth. I allowed them to respire about half an hour, and again immersed them in the warm milk, where they remained another half hour. I then took them out; two of them were still vigorous, but the third seemed to languish: I therefore ordered it to be carried to the mother; which, besides the three brought forth in the water, had littered other six in the natural manner. The puppy which was born in the water and had continued one half hour in warm milk before it was allowed to breathe, and another half hour after it had respired, seemed to be very little incommoded; for it soon recovered, and was as active and lively as those which had received no injury. Of the six that were brought forth in the air, I threw away four: so that there remained only two with the mother, beside the one that had been littered in the water. I continued my experiments upon the other two which had been twice immersed in the milk: after allowing them to breathe about half an hour, I plunged them a third time into the milk, where they remained another half hour. Whether they swallowed any of the milk I could not determine; but when removed, they appeared to be nearly as vigorous as before their immersion."—"I pushed these trials no farther: but I learned enough to convince me, that respiration is not so indispensably necessary to the existence of a new-born animal as to an adult; and that by employing certain precautions, it is, perhaps, possible to keep the foramen ovale open: and by this means, produce excellent divers, or a species of amphibious animals, which would be able to live equally in air or in water."

I cannot pay Mr. Buffon the compliment of thinking that he was deceived in so simple an affair as this; it was not the foramen ovale that he was to keep open, if he wanted to make Amphibia; but, since the function of the placenta was just cut off in these whelps, and since he did not allow them the office of the lungs, he was to seek for some other third function, which could stand in place of the functions of the placenta and lungs; and since no such function has yet been observed, I judge from all the principles which I have laid down, that Mr. Buffon was conscious that he had succeeded in no degree; and that he could no more have converted them into amphibious animals, than he could have made them what they were, viz. plain whelps. "Sed quis fallat omnisciam, ut sic loquar, naturam? Illa non colludit nostris erroribus, et quod ignorantia celaverat suo detegit tempore." Yet there is a peculiarity in the system of young animals, which, if it does not make them less dependant on the exercise of the lungs, does, at least in children, make them bear with defects of structure which prove destructive to more advanced life. By the function of the lungs, as we have stated, the heat of the body is preserved. Now the child in utero suffers no expenditure of heat; and this is one reason why the placenta and the provisions of the circulation of the fœtus do not furnish so perfect an apparatus of oxygenation as the lungs and adult heart; and so we shall find that when the child after birth suffers from some malformation by which it is imperfectly suited to its new condition, laying it in tepid water, as it were restoring it to its former condition, is the most powerful means of diminishing the intensity of the paroxysm.—This will be illustrated under the following head.

## OF MALCONFORMATIONS OF THE HEART, AND OTHER CAUSES, PREVENTING THE DUE OXYDATION OF THE BLOOD.

We are at no period of life, from the cradle to the grave, exempted from those diseases which prevent the due oxydation of the blood. They often are born with us; they often overtake us when advanced in life; they cause an anxiety and misery, which exceeds all other distress: pain and suffering of every other kind humanity can bear, but the feeling of instant dissolution is what the noblest mind sinks under. We know by the pale and subsiding countenance how awful the inward feelings are, and woe be to him who has not feeling enough to sympathise with this distress, and an anxious desire to understand the cause, and to alleviate the misery of inward diseases which he cannot cure!

These are seducing motives, and might of themselves have drawn me on to give this slight sketch of the malconformations and diseases of the heart: but I feel also the stronger motives of duty and necessity; for truly, without some knowledge of the ill organized, irregular, and diseased heart, the structure and functions of the heart in its sounder state would be but poorly understood. This sketch, then, is the last part of this anatomy of the heart.

While the following history serves to correct our notions of the mechanism of the heart, we must also observe how it explains and illustrates up to a much higher point the combined functions of the heart and lungs, viz. the oxydation of the blood. Perhaps nothing can better explain the effects of a full and healthy oxydation, than a sparing oxydation of the blood, such as produces disease.

The fœtus alone can live with its single heart; it lives in the womb by its having a heart different from that of an adult. A fœtus, then, being born, cannot live with that heart which served it in the womb;

and Nature, as I have explained already, divides the single heart, that is to say, closes the communication betwixt the right and the left side, and there is then a heart for the lungs and a heart for the body. But if any fault in the organization prevent this separation of the heart; if the foramen ovale be preserved open; or if there should be any hole in the septum betwixt the ventricles of the heart; if the pulmonic artery do not admit the blood, now that the child is born, and should breathe the air; if the aorta arise from the right ventricle, so as to carry off all the blood from the lungs; or if the aorta be so displaced, that its mouth stands in part over both ventricles, so as to receive the blood of both — then the organization, movements, and functions of the heart are all wrong; no blood passes into the lungs, the child cannot live; it either dies immediately in convulsive struggles, or lives in misery but a few years.

It is not in this rapid enumeration that these varieties of malconformation can be understood, nor yet do they deserve to be minutely detailed. I shall keep the middle path; and those of my readers will easily follow me who have studied the mechanism of the heart; concerning which this subject will recal to their memory all the important facts.

The most usual of all these disorders of the heart is some fault in the pulmonic artery, or some defect in the state of the great vessels in their origin from the cavities of the heart; and that disorder again is fruitful of others; for if the pulmonic artery cannot receive its blood, the foramen ovale cannot close: then the blood cannot circulate nor pass into the lungs when they first expand; then the office of the right heart is taken away, it has no power but to drive the blood with struggles through the foramen ovale into the left heart; the left heart then drives this blood, unoxydated as it is, into the aorta: the heart is now a single heart; it is the left heart alone that receives or circulates the blood: either it labours but for a few pulses, and then the child, after a con-

vulsive struggle, expires; or there is some degree of opening in the pulmonic artery, a little blood passes through it into the lungs; the child is by that enabled to struggle with its convulsive pangs for eight or ten days, and then expires.

Such a scene the celebrated Dr. Hunter once witnessed; and there was, I perceive, in that heart a peculiarity very much to be admired. The chief fault was in the pulmonic artery, which was contracted into a solid substance or cord absolutely and completely impervious, so that the lungs had never received one drop of blood by the pulmonic artery. And here I must stop to notice one thing which I have always suspected, and which this dissection proves, viz. that though it is natural to believe, and the best physiologists suppose it, that some blood, as much at least as to support the form of the pulmonic vessels, passes through the fœtal lungs; yet here is direct proof that a well-nourished child may be born capable of breathing, and in which the pulmonic vessels are all free except at the heart, in which not one drop of blood ever passed into the pulmonic circulation. But chiefly it is to be observed, that this child, with its pulmonic artery, quite impervious, could not have struggled a single day, far less ten days, without some proportion of oxydated blood! and accordingly we find that it had a small portion, just such as supported life for a few days; which small proportion it obtained thus: The blood went to be oxydated, not from the right ventricle into the pulmonic artery, but from the left ventricle into the aorta; from thence into the ductus arteriosus; and then, by a retrograde course, backwards through the lungs; and then by the pulmonic veins it was returned oxydated into the left side of the heart, from whence it came. This child accordingly lived a few days, and could not live longer; because this difficult circulation was continually accumulating a quantity of black blood in the right side of the heart.

This child, then, had a heart resembling that of

the Newt or Frog; for the pulmonic artery was closed, and the right heart of no value; the left heart pushed its blood into the aorta, and the aorta, as we may express it, sent a side branch into the lungs. In this first instance, then of malconformation, the child could not live, because it wanted the pulmonary artery, and of course the office of the right ventricle; it had but a single heart.

Next to this disorder of the pulmonic artery, viz. being obliterated or being closed, is this: That the aorta, in place of arising distinctly either from the right or from the left ventricle, is so placed, that its root stands directly over the septum ventriculorum, or partition of the ventricles; that the partition is perforated with a large hole, opening a very free passage from side to side; and that the heart being cut up, we find, upon thrusting down the finger into the aorta, that it passes with equal ease into the right or into the left side of the heart.*

In this conformation of the heart, the single heart appears again in a new form, and the office of the right or pulmonic side of the heart is well nigh annihilated. First, The pulmonic artery is small, sometimes almost close: Secondly, The aorta, arising as well from the right as from the left ventricle, carries off one half of that blood which should be circulated through the lungs: And, lastly, That blood, small as it is in quantity, which has passed through the lungs, is brought round to the left side of the heart; but the left side is not as it should be, close, to keep this purer blood for the circulation of the body, but it is mixed with the blood of the right side, through the perforated septum; so that its virtues, as oxydated blood, are diluted or almost lost.

If the pulmonic artery were unaffected, and the aorta placed equally over both ventricles, then the one half exactly of that blood which should be oxydated would undergo the change. But in all these

* This is by far the most common defect or malformation of the heart.

malconformations, the root of the pulmonic artery also is in fault; it is narrow; it is so small, that at first opening such a body it alone attracts the eye; its mouth is sometimes so beset with a sort of fleshy granulous papillæ, that there is hardly left opening enough to pass a silver probe. The degree of contraction in the pulmonic artery is the true measure of all the oxydated blood which that system can receive; but in such a system the quantity is still farther reduced by various accidents of the organization. Thus, for example, — The pulmonic artery, is, we shall suppose, but one-third of its natural size, and the original quantity of oxydated blood is proportionably small; — next, the foramen ovale, being open, carries off much blood towards the left auricle; the aorta, planted over the right ventricle, carries off also much blood. But let us suppose, that still as much remains as to fill the pulmonic artery to its full: when the pure blood comes round to the left side, it is mixed through the foramen ovale, and through the breach of the septum, with a quantity of black blood, which is continually accumulating upon it; and the small quantity of oxydated blood is, if I may use the expression, drowned in the general mass.

That I may explain the point of its accumulating a little farther, let me repeat, that even in a child which has died on the tenth day of such a disorder, the heart is crammed with dark-coloured blood: that in those children which have lived two or three years under such a distress, the heart has been greatly enlarged: that in a boy dissected by Sandifort, who died at fifteen, the thing that was first seen upon opening the body was, not the lungs covering the heart and lapping over it, but a large mass, lying betwixt the lungs, oppressing them and pushing them aside in every direction. This was the pericardium covering a heart of enormous size, filling the thorax, and reaching almost to the first rib: very little of the right lobe of the lungs, and none almost of the left, was to be seen; the veins in the upper part of

the thorax, viz. the subclavian and jugulars, were choked by the pressure, and much distended; the heart itself was full of blood, and the coronary veins so turgid, that it resembled a most minute and beautiful injection of the heart.

But it is most of all singular, that this heart was so enlarged, that the great veins, (which are indeed as reservoirs for the right side of the heart,) and especially the upper cava, dilated along with it in such a degree that there was felt distinctly a pulsation in the neck by a sort of back stroke every time the heart beat.

Still a child, even with a heart so ill organized, may struggle through all the weakness and all the diseases of childhood* for a few years, but they are years of complete misery; and still, as is proved by much sad experience, the boy cannot live, but must die.

Another conformation, the strangest of all, is that in which new parts are added to the circulating system, as if with design to make it resemble the heart of an amphibious creature; for it happens, sometimes, that there is as it were a third heart interposed. For example, the two venæ cavæ end in the right auricle, the pulmonic veins enter into the left auricle, and the right and left ventricles receive their blood from their auricles in the usual way; yet the right ventricle sends out no pulmonary artery, the left ventricle sends out no aorta: but both of them pour their blood into a middle ventricle, and the arteries go out from it: and here, as the blood is fairly delivered by both ventricles into this third ventricle, and as the pulmonic artery and aorta both arise from it, there is, of course, a fair division of the blood; and of the quantity which should be oxydated, exactly one-half undergoes that change. This is somewhat like the heart of the Turtle: it is plainly the

* Sandifort attended a puer cœruleus, who, in addition to his chief disease, passed through the small-pox and measles safely, and attained the age of fifteen.

structure of an amphibious heart, a single heart; for though there be three cavities, yet are they single in their function: it is a single heart with half oxydated blood. Such a heart is sufficient for Amphibia, or for the fœtus; but not for a child, which must breathe and have a double heart.

These are a few of the varieties of the imperfect heart; but the sufferings of children who are born with these imperfections, the marks of imperfect oxydation, and the manner of their life and death, was a chief motive for entering on this subject.

When the heart is so imperfect that the child lives but a few days, its sufferings are slight, and not lingering, so that we cannot mark them: They are not explained to us by any account of its inward feelings: They are all accumulated into one terrible struggle, in which we see the worst marks of ill oxydated blood.

The child is born well and healthy, it cries and draws its breath, it is removed from the mother; the function of the placenta ceases, but there is no other to succeed it; the child turns black in the face, struggles for breath, and is convulsed; and without any apparent cause it seems in the agonies of death: but yet it lives, it becomes black all over the body; the blackness never goes off except when it changes sometimes into a deadly ash colour. The child continues for a few days labouring under almost unceasing convulsions, which growing gradually weaker, it at last expires; and while it lives, the heart palpitates; sometimes it throbs so, that it can be distinguished at a distance by the eye. Dr. Hunter, in the child which I have already mentioned, laid his hand upon the breast, and the throbbing which he felt there was terrible to him.

When the child has the heart so formed as to admit into the lungs even a very small proportion of blood, it struggles through the first years of life, and its protracted sufferings can be more easily observed. Then no mark of ill oxydated blood is wanting; every

thing is the reverse of health, or the natural appearance flushed and florid of a growing child; its colour is always dark, its motions languid and powerless; it is cold, so that the parents must keep it carefully wrapped in flannels and furs to preserve any thing of vital heat; its breathing is difficult and distressed; fits come upon it at times; and if the child has begun to walk, the least hurry, or fear, or quick step, even walking across the room, brings a return of the fit: in which the extremities are deadly cold, the face black, the breathing one continued struggle, and the end of the fit is the obtaining of a degree of relief, which happens in a most singular way.

The coldness, the livor, the languor, the fainting, the struggle for free breathing, are all marks of ill oxydated blood. The convulsive paroxysm is a sure consequence of the want of stimulus and force, and of blood accumulating on the right side of the heart. If, then, the child fall down in this paroxysm, it is the very surest proof that ordinary respiration will not save him from the struggle: if during the fit he breathe so that he recovers, and that presently his strength, colour, spirits, every thing, is in a degree restored; then it is plain that the respiration during the fit, imperfect as it appears to us, is really more effectual than ordinary respiration.

When we observe which is the most natural way of obtaining relief, and notice the very peculiar manner in which these children breathe, we shall understand why they are breathing best when we believe they are hardly getting breath, and how they are recovering slowly when we think them labouring in the greatest danger. The child, feeling the growing oppression at its breast, if it be young, signifies a desire to be turned upon its face; if not indulged, it contrives to turn itself that way before its hard struggle begins. When the child begins to breathe hard, it drives out the air with a sudden exertion, and apparent pain; he remains longer without respiration than an adult could do; his expirations are

attended with a sort of scream. What can this way of breathing mean? To my apprehension it implies that kind of breathing which I have called forced respiration, and no other plainly can serve.

The ordinary respiration, by which we draw in 40 cubic inches of air, has failed; the fit is approaching, because that quantity of air will not suffice. However rapidly the child breathes, however rapidly the heart palpitates, it will not do, because there are but 40 inches of pure air mixed with the whole of that great mass which remains always in the lungs. Then the child, driven by instinct, provides for the fullest respiration: it turns upon its face, that the weight may help to compress the thorax; it forces with all its power, and seems to cease from breathing, and refrains a long while in that state because it is emptying and compressing the lungs. Then its purpose is accomplished; the lungs are more emptied than in ordinary respiration; it draws in the largest draught of air, utters a sort of scream, seems quiet again: and again, by pressing its breast, and by contortions (convulsive like) of its body it empties its lungs at a distant interval, and receives again the fullest draught of air. It is this forced respiration that brings into the lungs 70 cubic inches of air, (if we were speaking of the adult,) more than the usual respiration does. This, then, is three times more effectual than ordinary breathing: and when a boy grown up to those years in which he knows the warnings of his disorder, and has found out this relief; when such a boy by pressing upon the corner of a table, or by throwing himself upon the ground, prevents or alleviates his paroxysms, — in what way can it be but by practising for a time this deeper respiration; pressing the chest, forcing and compressing the lungs beyond their usual degree of collapse, and so obtaining a fuller draught, a draught of 110 inches of air, to be mixed with the 110 inches which must always remain in the lungs?

After half an hour of a kind of breathing most

awful to behold, but much more effectual than common breathing, the child recovers slowly. The boy, when advanced a few years, knows how to prevent the fit; but the child of two or three years old knows only how to struggle with it: yet this struggle being a more effectual breathing, the child is relieved at once from an anxiety, and oppression, and throbbing, which precedes the fit for many days; the languor goes off, the heat in some degree returns, and the lips acquire a vermilion colour, and the skin a higher tint, which last for many hours after the fit is gone.

In those children, again, which have the heart so formed that they may live, not two or three years only, but to the age of 15 years, it naturally happens that the symptoms follow each other in their course very slowly; and the ill oxydation of the blood in this its slower progress it is very curious to observe.

There is one thing in the economy of the fœtus very singular — the child, the chick, the fœtus of every kind, need less of this principle of oxygen: the fœtus lives (if this be so) like an amphibious creature; perhaps it has little oxydated blood; yet being totally deprived of that little, it soon dies. Perhaps the fœtus, living the life of an amphibious creature, is not without some of that peculiar tenacity of life which characterises that class; for the struggles and sufferings which a weakly infant endures, before it parts with life, are matter of observation even among the vulgar. Another circumstance is obvious from our preceding account of respiration. The office of the heart, lungs, and circulation, has among other functions to produce heat. But the fœtus still in the mother's womb cannot expend heat, and therefore cannot require its generation. Independent of other offices requiring a more perfect circulation (and when I say circulation, I include respiration, which is in a manner a part of it), the child visiting the light, and living in an atmosphere colder than its body, requires to generate heat. Here is

one cause of the violence of these paroxysms, when the apparatus of circulation and respiration are imperfect. And this is the reason that immersing the child in warm water is one of the most effectual ways of relieving the fit.

But to return to our first position, it would appear that children have a greater degree of tenacity of life, or are capable of struggling against the defects of respiration. For this reason, I believe, it is that children, having a heart so ill arranged, that absolutely they cannot live beyond the years of puberty, yet during the first year feel no complaint, and seem thriving and healthy; the vegetating life of a sucking child saves it from all dangers of hurried respiration and rapid pulse. — But when it leaves the breast; when it begins to stir and move; when its blood moving languidly, begins slowly to accumulate at its heart; when the properties of its living fibres change so as to require a fuller supply of oxygen from the blood — then the unhealthy colour, languor, palpitations, slighter fits, and all the marks of its disease, begin; and often its colour gradually changes, and it becomes the puer cœruleus, or livid child, before we can perceive by any other marks how dangerous a condition it is in.

In one child* the first year had elapsed before the very slightest of those complaints came on, which ended in death at a very distant period of fifteen years. At first, its finger-nails were observed to be livid, yet not continually; the colour varied, but still the nails were unnaturally livid, so as to alarm and surprise the parents: but there was as yet no reason to desire advice. The child seemed healthy, began to use its legs, and in the second year it walked alone.— Next, it happened that one day, after being forced to take a medicine, not without some resistance, his face was on the following day freckled with red spots, which soon changed to a livid hue. Now the

* Vide Sandifort.

lassitude and chillness came on; motion or exercise was more and more oppressive to the boy; till at last, when he fatigued or hurried himself the hands and feet became livid, the mouth and tongue became almost black, and last of all, those fits came on in which the whole body becomes livid or black.

This is the progress of this darker colour of the body; but his other complaints also advanced with a very slow and regular pace. He increased in stature; his appetite was good; he complained of great lassitude; of head-ach, with a sort of gravitating pain; of anxieties, especially during the winter months; and of such extreme coldness, that neither fire in winter nor summer's sun could warm him: he never felt heat except when just wrapped up and newly laid in bed.

Now the blood began to accumulate; the struggles of the heart began; and so terrible were the throbbings of his heart at times, that they might be seen, or even heard. Actual faintings succeeded; the poor boy, now eleven years of age, knew that he was to die; he said, that "no one could know or cure his illness, and that no one could imagine what feelings he had here at his heart."

Motion was now quite impossible; upon the slightest effort saliva flowed from his mouth, a fainting fit ensued, and he continued for a little while blind. All that he was wont to delight in was now indifferent to him; he could not move; his face was turgid, his eyes prominent, his feet were swelled with an œdema, his eyes dead and heavy, expressive of some inward distress; when he was put to bed his anxieties were very great, and thus he died a slow and miserable death. A case nearly similar to this occurred very lately, and the preparation was added to the collection in Windmill-street. The whole sufferings of the child had been attributed to the effects arising from the sudden death of its grandmother, while the child was asleep in the same bed; yet the condition of the heart showed evidently that

the cause was of a permanent nature, and must have been from birth. And here we have another instance, that as the constitution advances, it is more iufluenced by the privation arising from malformations.

Sometimes a child wants spirit or strength to strive against the lassitude of this disease. A girl under Vasalva's care lived to her fifteenth year; but from her infancy, from her very birth, she had lain in bed, partly on account of sickness, but chiefly on account of extreme weakness. She had a short and difficult breathing, and her skin was tinged all over with a livid colour; her quiet state saved her from the suffocating paroxysms; but her heart was just like all the others, the foramen ovale open, and the pulmonic artery closed.

These, then, are the marks of imperfectly oxydated blood: a livid colour, coldness which nothing can remove, oppression and anxiety of the breast, palpitations and difficult breathing; and when the blood is by passion or motion hurried too fast towards the right side of the heart, then come fits, which last a longer or shorter time in proportion as they have been long delayed, and which end in death. And, last of all, I would rank among these consequences an imperfect nourishment; for all the boys have been small, most of them particularly slender; and one boy especially, of fifteen years of age, is mentioned by Dr. Hunter, who, in respect of tallness, was just what you should expect at his years, but slender to a wonderful degree; not as if wasted by consumption, but as if by natural habit. His form was quite surprising, so that Hunter could give no idea of his shape, otherwise than by comparing his body with that of a Greyhound; and his legs, he says, put him in mind of those of a Crane, or some tall water-fowl.

When we see the effect of this insufficient supply of that for which the lungs are provided, we cannot but reflect on the idea of Mr. Cline, that in animals the capacity of the chest is the measure of their strength, and their power of receiving nourishment.

A fact illustrated by the opinion of the grazier or the horse jockey.

## SIMILAR CONSEQUENCES FROM MALCONFORMATION OF THE LUNGS, AND FROM THEIR DISEASED CONDITION.

The consequences must be alike, whether it be that the heart sends no blood towards the lungs, or that the lungs cannot receive that blood; and the malconformations of the heart are hardly more frequent than those of the lungs; and both, we may be well assured, are infinitely more frequent than we suppose; especially when we observe how many children die suddenly, discoloured, and in convulsions; and how many of those advanced in years have lived very miserable with complaints in the breast.

A young man of twenty-four years of age, by birth a Pole, and at the time of his death a soldier in the German service, had been continually oppressed from his cradle upwards with difficult breathing and anxieties at his breast. He had been three or four times relieved from slighter complaints of the breast; but at last the bleedings and demulcent medicines failed: he lay ill in the military hospital two months, where of course his complaints were correctly known. He had none but the slighter degrees of difficult breathing; when one day sitting up in bed he suddenly expired. Being opened, the right side of the lungs was found to be totally wanting; not destroyed by disease, as we have often seen, not oppressed by water, nor eroded by pus, but entirely wanting; a peculiarity which he had from his mother's womb, for it was attended with a peculiar arrangement of the vessels. On the right side there was no vestige of the lungs, not even the smallest button to mark where they might have been; there was no branch of the trachea for the right lobe intended by Nature, but both the legs of the trachea plunged into

the left lung, which was large: there was no forking of the pulmonary artery to give a branch to the right side, but the whole trunk of the pulmonic artery plunged into the left lung.

But if one should suspect that there might have been once a right branch, the lungs destroyed, and the mouths curiously united by that coagulable lymph which the membranes of the viscera, and the pleura especially, throw out when inflamed; there are still other cases which must remove all our doubts, especially that of a young man*, who died in a very lingering way, and in whom, before his death, there was plainly perceived, along with his slight anxieties, a pulsation in the right side of the breast. Upon opening his body, there was found in the left side neither lungs nor heart; nor, upon the most careful examination (seeking for the wasted lung), could there be found the smallest remains of lungs, bronchiæ, pulmonic arteries, or the slightest evidence that any such parts had ever been. But the surest proof of this remains behind, for the heart stood in the right side of the chest; it stood perpendicularly, quite upright like a dog's; it gave out a right pulmonic artery, but there was not even the smallest vestige of any artery having been appointed for the left lobe. We must not say, but that his chest may have been full enough of lungs and heart, and he may have had a well oxydated blood; in which case, it was no very dangerous derangement that his lungs were all on the right side, more than if his liver had been on the left. But let us notice that the aorta was extremely small; the diameter of the aorta is the true measure of the blood which is received from the lungs. Where the aorta is small, surely the lungs are not good, nor the system fully supplied with oxydated blood.

We also know, that though the vessels of the lungs themselves may be natural and well arranged, the lungs may still be amiss; they may want the proper

* Under the care of Dr. Heberden.

structure of cells in which the blood should be exposed; they may be encumbered with tumours arising out of their substance, by which they will be prevented from dilating. One is pleased to find in old authors good descriptions of diseases which have remained for ages unknown; and among these I reckon that of the celebrated Spindler; whose description I admire as much as that of any succeeding author.

The child of a certain prince having died after a few days of great suffering, Spindler opened the body, and found all sound and right, except that there was seated upon the two lungs two tubercles of a variegated red colour, as were the lungs themselves; which tumours, no doubt, hindered the passage of the blood, which he expresses with a correctness in respect of physiology quite unknown in those times. "Quæ vomicæ procul dubio hujus asphyxiæ causæ extitere denegata circulatione ex dextro in sinistrum cordis ventriculum." His description of the disease so long before it was properly understood is curious: "During the eight days in which the child lived, it had never cried strongly nor clearly, had never sucked, had never been regular in its bowels, breathed as if its sides had been blown up; it was suddenly seized with a fit, which seemed epileptic, soon went off, but soon returned; the whole face and body became first red, then of a copper colour; the breathing was interrupted, the eyes immoveable, the feet and hands lay almost lifeless; it suffered at least a hundred of these fits before it expired."

To enumerate those cases where a defect of the lungs was the consequence, not of malconformation, but of disease, were a business quite inconsistent with my design; yet I wish to record these two.—First, It has been long observed, that by long continued suppuration, the lungs are so often wasted that not a bud or particle of them remains: sometimes these patients survive, dragging on a languid and miserable existence, enjoying no freedom, life, nor spirits; and

the cause of their frequent ailments is discovered at their death. The lungs also may be thus compressed even by the mere pressure of water within the chest, which has caused such a subsiding, or rather absorption, of the lungs, without any ulcer of their surface, that one lung has been oppressed till it became no more than three lines in thickness; and indeed it was not easily found: so Haller says in his Commentary upon Boerhaave. But of all the strange things which Haller, or any man has ever related, what he tells in the following words is the most incredible; at least it is so improbable as to be incredible: "A man having died of a lingering disease occasioned by a fall, the left lobe of the lungs was not to be found; that side of the chest was full of a coagulable serum; but the aspera arteria and large arteries and veins (a thing which I never could have believed, had I not seen it myself,) opened with gaping orifices into the cavity of the thorax, as if they had been cut across; so that it was very hard to conceive what had prevented the blood from pouring out." Haller, p. 34.

The truth is, that the vessels appear open when they are not; for within their gaping mouths there is a secretion of coagulable lymph, and the formation of a clot of blood which stops them.

Secondly, in the peripneumonia notha there is not merely an inflammation of the pleura, as the name expresses, but of the lungs themselves; and it is not from inflammation, pain, fever, or acute suffering, that the patients die; but because the lungs are entirely crammed with blood, the heart can no longer move; they are not sensible of their dangerous state, but are suffocated in a moment, and die without a groan. It seems more frequent in other countries than in this, though no country is exempted. When this disease comes upon a place, it comes with all the frequency and destruction of an epidemic disease; and the sudden unexpected deaths are terrible. Valsalva found an old gentleman going abroad in the morning, and prevented him, questioning him about

his complaints, which he himself thought very slight: but Valsalva gave notice privately to the servants to expect nothing better than their master's death ; and notwithstanding all assistance, he was that very evening dead.

The pulse is weak, the cough slight, the difficulty of breathing more anxious than painful; the face sunk in the features and flushed, or rather of a lurid colour, except when it is cadaverous, pale, and sallow; the suffocation is sudden; the lungs have, as Morgagni expresses it, a liver-like, solid consistence; they have no longer the cellular appearance of lungs, for their bronchiæ are crammed with blood; their common cellular texture is also full of exuded blood; they are dense, solid, very heavy, and black, and they sink in water like the lungs of a fœtus. The heart is so curbed in its actions, that it gives but a small, feeble, and trembling pulse; and even in a few days (as in the fœtus having an imperfect organization) the heart is wonderfully dilated and enlarged, and filled wiih fluid and grumous blood. Haller laments the death of friends by this terrible disease, and especially of his own son, "whose body he gave to be opened by those skilled in dissections." A long continued difficulty of breathing, proceeding from disorder of the larynx, will much in the same manner deprive the lungs of their power of oxygenating the blood. Effusion takes place into the texture of the lungs, so as to compress the air-cells; and sometimes the natural mucous secretion of the bronchiæ is so increased as to impede the entrance of the air. By which the cells are choked, and the lungs become incapable of oxygenating the blood.

I have here confined the disquisition to the illustration of the natural functions of the heart and lungs: and therefore I have struck out of the present edition some observations very curious in themselves, on the diseases of the heart, which however, were I to admit, and were I to follow up by the introduction of other divisions of the pathology, would lead us too far.

# OF THE ARTERIES.

## THEIR STRUCTURE.

The membranes which form the coats of the arteries, may be separated into many plies or layers; but properly there are three coats, distinguishable by structure and use. Besides these proper coats, the arteries, and indeed all vessels, have a surrounding sheath of condensed cellular texture. I shall begin my description with this exterior covering.

## OF THE SHEATH OF THE ARTERY.

The sheath of the artery is a coat of loose cellular texture, which surrounds it. It may be traced from the exterior layer of the pericardium, along the aorta and all its branches, till it escapes the eye, from the delicacy and minuteness of the ramifications which it surrounds. It has connection with the common cellular membrane in the interstices of the muscles, and with the fascia; so that it forms the bond of union betwixt the vessels and the surrounding substance of the limb: as in general, an artery is accompanied with its veins (the venæ comites), and with a nerve, and generally with lymphatics, the cellular texture forming the sheath is common to all these, envelops them, and binds them together. But, again, it is important to the surgeon to observe that the artery has, appropriated to it, a division of this sheath. For the sheath of the artery is strengthened by ligamentous filaments, so as to form a sort of vagina in which the artery lies, and to which it is attached by very loose and elastic filaments of cellular texture.

External coat.—The exterior proper coat of an artery, sometimes called the tendinous coat of the artery, is dense, strong, tough, and elastic.* The

* Tunica *cellulosa propria.* Haller. *Cartilaginea.* Vesalius. *Tendinea.* Heister

power of resisting the force of the heart, that is, of resisting over distension, is very principally seated in this coat. When a ligature is tied about an artery, it is this coat which, by its toughness, withstands the operation of the cord, when the internal coats are cut and give way. It may be dissected into several layers, especially in an old subject.

Muscular coat.—The middle or muscular coat of an artery is of a very distinct structure; for although some (trusting to chemical tests, and neglecting the finest suite of experiments by Mr. Hunter, which go to prove the muscularity of the arteries,) have denied that this coat consists of muscular fibres; yet there is not the slightest doubt that it is fibrous, that these fibres contract, and that they lose their contractile power on death. This coat consists of fine muscular fibres, which run in a course around the artery: none go in the length of the artery, nor run obliquely in the human subject. It is a mistake to suppose that these are not visible in the greater arteries, although it be in the smaller branches that they bear the largest proportion to the other coats.

Indeed, it is well known that the arteries possess two distinct properties: 1. Elasticity; 2. Muscularity. The former quality is possessed, in the greatest degree, by the arteries near the heart: the latter quality is possessed, in a larger proportion, by the arteries more remote from the heart. The elastic property is well calculated to resist the shock of the heart's action, but in the extremities this is not necessary, for there the violence of the heart's motion is subdued or diminished, and then, consequently, there is a necessity for a second power, similar to that of the heart, viz. the muscular power of the arterial coats.

Internal coat. — The inner coat of an artery, sometimes, but very improperly called cuticular coat, is very thin and smooth, and very easily torn, especially in its transverse direction. The density and fineness of its texture is for the purpose of retaining the blood, and its smoothness for permitting the blood to

flow with the least possible interruption. But there is another property, more difficult to comprehend fully: an endowment of life, and a mutual influence, which exists betwixt this coat and the contained fluid, without which, as it appears to me, the circulation could not proceed at all.

The VASA VASORUM are those small arteries and veins which enter into the coats of the artery, to nourish them, and to support their living properties. For the blood within the cavity of the artery, though it be arterial, is not capable of giving a supply, neither of nourishment nor of power of any kind to the coats; by which we see that it is not the contact of arterial blood that suffices to the supply of living parts, the blood must be sent through the small arteries, and must suffer the agency of these small arteries.

The vasa vasorum pass to the proper coats of the arteries, by perforating the sheath, and are carried through, as it were, by the support and connection of the cellular membrane. It is this circumstance which makes the surrounding cellular substance of the artery a matter of vast importance in operations on the arteries, for if it be destroyed, so also are the nourishing vessels, and then the artery is a dead tube, and sloughs under the ligature.

CELLULAR COATS.—There is a cellular coat betwixt the sheath and the outer tendinous coat; another layer of cellular membrane intervenes betwixt the outer and muscular coat; and, again, a third layer of cellular substance, (which, however, is very fine,) is interposed betwixt the muscular and inner coat of the artery.

## OF THE MOTION OF THE BLOOD THROUGH THE ARTERIES.

There is no subject of physiology more important than the consideration of the causes which accelerate or retard the blood in the arteries, and none on

which it appears to me that more extraordinary mistakes have been entertained.

The increasing muscularity of an artery, as it extends from the heart, is a provision for giving increase of arterial power in proportion to the diminution of the power of the heart. By the due distribution of these two powers the blood is made to circulate with an equal velocity in parts near and in parts remote from the heart; yet the length of an artery has been considered as a means of subduing the velocity of the blood, and the tortuous form of an artery has been considered as the most effectual check to the force of circulation. Exactly the reverse of this is the case. A few examples will prove it. The blood mounts against the power of gravity to the head; an increasing tortuosity distinguishes the arteries of the head. And so the arteries of the temple and the occiput increase in their tortuosity as they advance upwards. The arteries of the mamma go in a straight course while the woman is not suckling, but if she should die while nursing, then the tortuous form of the arteries may be demonstrated by injections, and is very remarkable. If a tumour grows upon any part of the body requiring or exciting a greater flow of blood to the part, then we find that the vessels of the part which in their natural state are nearly straight, assume a tortuous form at the same time that they are enlarged. The surgeon knows well that if he cuts a tortuous vessel in an operation, the blood flows from it with a force much greater than from a vessel in its natural state. If the muscles of animals require much and long exertion, they require also more blood to preserve an increased irritability or power of action, and therefore they require tortuous arteries. Thus the muscles of the jaws of the lion, the muscles of such animals as cling and hang to branches of trees, possess tortuous arteries to carry on the circulation with more than common power during their long and powerful contractions. More numerous proofs might be given to show that the tortuous artery,

being an artery with an increased muscularity, is ever a more powerful artery. Another circumstance may be demonstrated, and that is, that a tortuous artery is one which impedes the blood while it is passive, and has an unusual power of accelerating the blood when its muscular coat is excited.

It appears to me, that the nature of the forces circulating the blood have been much overrated by experimenters, from the neglect of a principle which more than any other should raise our admiration, and is important in the practice of surgery. They have calculated the power of the heart by the difficulties to be overcome in the circulation. They have made a fluid of the exact degree of viscidity of the circulating blood; they have put this into a glass tube, the extremity of which was drawn into a capillary vessel; they have raised the fluid in the tube until it flowed through the capillary extremity, and by the height of the column they have calculated the force necessary to push the fluid onward. But the operations of nature in a *living body* cannot thus be calculated, for there must come a living property into the estimate. The Creator has not contrived means of overcoming an obstruction, but through the influence of life has removed that obstruction altogether, which exists in dead parts. These experimenters are contriving means to measure the cohesion which takes place between the fluid and the solid parts, but it would have been well to have enquired whether in the living frame such attraction takes place as exists between the particles of dead matter, or whether or not that attraction was modified by the influence of life. In fact, in the living body, the cohesion or attraction betwixt the fluids and the vessels is destroyed; there is no such cause of retardation as we witness in dead tubes in inert matter. A weak impetus propels the blood, because it has not the force of attraction to overcome; but if by injury, inflammation, or any other derangement, the peculiar influence existing betwixt the vessels and their fluids is deranged, attraction takes place, then the blood

adheres to the sides of the vessels, coagulates and stops; which is the occasion of the spontaneous stopping of the blood in cut vessels; and, I must add, that this is a principle most strangely overlooked in many ingenious books, which offer an explanation of this circumstance.

When we have persuaded ourselves that we have arrived at some just notions of the power circulating our blood, and have in imagination placed the frame of the human body before us, and contemplated the various results from the circulation of a living fluid, our conception of these wonders is imperfect, until we see the body in activity, and witness the effects upon the blood, of the change from repose to exertion.

The instant that a man becomes animated, or starts into exertion, the motion of the blood is thrown into disorder. There is no longer the measured activity of the heart, and the gentle and equable motion of the lungs. The whole vital organs suffer the nature of a revolution. Is this an error or an imperfection in the frame-work? Far otherwise; out of this agitation, and seeming irregular violence, come additional means for sustaining the activity of the body. It is like those changes in nature, storms and tempests, and extremes of heat and cold, which seem the forerunners of misfortune, but which remove whatever is stagnant and noxious; preserving all nature in healthful activity.

The valves of the veins are provided for the exercise of the body; through them the pressure of the muscular frame-work, when employed in walking, running, leaping, or any sort of exertion, becomes a power additional to that of the heart and arteries in circulating the blood. While the veins are tubes, conveying back the blood which was sent out by the arteries from the heart, they are, from their capacity and their numbers, also reservoirs of the blood which moves through them languidly. The veins are compressible by the muscles: this compressibility is so

far from being an imperfection in the apparatus of the circulation (an opinion too hastily received), that it is attended with the most happy result; since through this effect solely, there is ever preserved an equality betwixt the force and rapidity of circulation and the muscular exertions.

Without the valves of the veins, which hinder the blood from moving retrograde, the pressure of the muscles would not effect this purpose of throwing the blood in increased quantity upon the heart; the blood would be forced by exertion to the extremities, instead of towards the centre of the circulation. The observations of those who preceded Harvey went thus far, and Fabricius distinctly says, that the valves of the veins were to prevent the blood from being forced outwards upon the extremities during exertion. They can bestow no additional activity, they only direct the impulse received from the muscles of the extremities towards the heart.

The heart assumes an activity proportioned to the blood which it receives; and the lungs, always in sympathy with the heart, partake of this activity, and the respiration is increased. The office of the lungs is to render the blood capable of supporting the life of the body, and in an especial manner the irritability of the muscles; now the motions of respiration are in proportion to the quantity of blood which has been compressed from the veins, and placed under the more active operations of the heart and arteries. It is thus that an activity is given to the circulation, and consequently the means of supporting the irritability of the muscles, in the proportion to its expenditure in exertions.

The circle of operations is in this succession; the muscles compress the veins; the heart is distended with blood; the lungs are excited by the state of the heart, the activity of the circulation and the respiration is thus promoted: and the effect is, that the circulation in the muscles is increased, and their irritability thereby supported.

The action of the muscles has not only an influence in sending back the blood to the heart, but also in accelerating the flow of blood outwardly through the arteries. In performing an operation on an infant, or trying to suppress a hæmorrhage from a drunk man, I have witnessed, with surprise, the additional force given to the jet of blood from an artery during the moment of exertion.

It is fortunate that we can have recourse to the account of experiments made by a man of veracity, instead of repeating hateful experiments on dying animals. When Hales was attempting to estimate the power of the heart by attaching glass tubes to the arteries of a horse, and admitting the blood to rise into the tube, he observed that an occasional variation took place in the length of the column of blood; and this not attributable to the force of the heart, but to the exertions of the creature. He saw, even in the moment of its expiring, that the blood rose remarkably in the tube; and that on stopping the nostrils of the animal, the blood rose five inches; that it rose considerably and suddenly on the animal drawing a deep inspiration.

Hales observed accurately, but he drew a wrong conclusion. He thought this additional rise in the column of blood was owing to the dilatation of the lungs, and the greater freedom with which the blood passed from the right to the left side of the heart. On the contrary, we know that, during a struggle, there is a greater difficulty in the circulation through the lungs. The true explanation of this effect must be derived from the observation of the manner in which the heart and great vessels are guarded, by the tension of the membranes which are around them; and which tension is increased in a remarkable manner during the violence of corporeal action; without which, indeed, the heart would be overpowered by the blood sent in upon it; and by which the additional force of the abdominal muscle and diaphragm is still employed in accelerating the blood in the course in which it ought to flow.

In this review of the forces circulating the blood, by giving to the vessels, and to the membranes surrounding the heart, their due importance, I have somewhat diminished the value of the heart's action, and reduced it to the regulation of the general current of the fluids, and the action of the lungs in connection with the circulating system. When we reflect that the blood of some creatures circulates without a heart, and see acephali born without a heart, yet fully nourished, — and when we see the aortic system of fishes removed almost out of the influence of the heart, — and when we see that the heart of all animals is placed in juxtaposition, and in accurate sympathy with the lungs, — it is impossible to refuse assent to the proposition, that the arteries possess the chief power in circulating the blood through the corporeal system; and that the heart is rather the regulator than the prime and efficient cause of the circulation. And by this it is not only meant that its state of excitement and activity commands and draws after it the motion of the blood generally, but that it regulates the actions of the lungs, in exactly according with the state of the blood and the necessities of the system.

I have shown that the irregularity in the demand of remote parts for blood cannot be answered by the acceleration or diminution of the heart's action; that the principal organs of the system have a provision for that partial increase of activity in their vessels which does not disturb the general economy, nor call for the action of the heart. I think I have shown that the object could not be effected by the increase or diminution of the heart's activity; and that if the endowment and vital properties of the organs were entirely dependent upon the general force of circulation, and not on the capacity of their own system of vessels, to increase or diminish the force of the blood, life would be held by a still more precarious tenure than it is: the vital action would interrupt the general system, and the agency of passion, and mental,

and even corporeal activity, would disturb the economy of the organs essential to life.

For entering on this subject I have offered the apology, that I felt myself obliged to do so by the nature of my daily occupations. But surely there is another and better reason in the nature of the subject itself. To ascertain the difference between fluids moving in pipes, and according to the laws of extended nature, and the circulation of fluids in the vessels of living beings, must be an important part of science. It is interesting to him who loves to take an extensive survey of nature, and very important to the student who is about to devote himself to the survey of animated nature, to perceive, by these proofs, that there are new principles and new laws to be studied. By the novelty of this enquiry, to some it may prove the occasion of opening those sensibilities to the works of nature which, by habit of inattention, have been lost to things seen in the more familiar path of existence. To contemplate with the microscope the circulation of the blood in minute vessels, makes the head giddy, so surprising is the rapidity of the globules of blood; and on raising the head, and calmly considering the matter, the surprise does not cease; we have surveyed a new world, where the velocity and seeming impetus have no sufficient cause, and to which the laws of things hitherto familiar do not extend.

## GENERAL PLAN OF THE ARTERIES.

### AORTA.

The arteries of all the body (excepting only those of the lungs employed merely in oxygenating the blood) arise from one trunk, the aorta; which we must describe as of great size, since we compare it with other arteries, but which is wonderfully small, considering that it is of its branches only that the whole arterial system is composed.

Those will have the truest notion of the distorted form of the aorta who have studied the anatomy of

the heart. Its root is deep buried in the flesh of the heart. In the Tortoise we see the flesh of the heart rising round the root of the aorta, and endowing it with the power of a second ventricle: in the Frog we find its internal surface beset with a triple row of valves, and its coats are like those of a ventricle, they are so exceedingly strong: in Man we find it plainly muscular, surrounded in circles with great fibres, and having much muscular power.

The beginning of the aorta, then, lies deep in the flesh of the heart; it is there that it gives off its coronary arteries: it bulges at its root into three great knobs, which mark the place of its three valves, and are called the lesser sinuses of the aorta; it is large at the root, it grows smaller as it rises, it mounts upwards and backwards from the heart, till it begins to form its arch or curvature; its direction is first towards the right side of the thorax; looking backwards, it turns in a very distorted manner, where it forms the arch; it strides over the root of the lungs, going now to the left side and backwards, till it touches the spine; its arch lies so upon the forking of the trachea, that its aneurisms often burst into the lungs: it then applies itself close to the spine, so that in aneurisms the pressure of the aorta often destroys the vertebræ; and now lying along the left side of the spine, and with the œsophagus running close by it, it passes down through the thorax, and from that to the belly under the crura of the diaphragm.

This, then, may serve as a short description of the aorta, which is the root of all those arteries which we proceed now to explain. It is the trunk from which the general tree of the arteries is to be traced.

From the arch of the aorta go off three great arteries, which rise to the head, or bend sidewise towards the arms, and so nourish all the upper parts of the body. Of these three arteries, the first is a great one, named Arteria Innominata, which contains, if I may so express it, the RIGHT CAROTID and the RIGHT SUBCLAVIAN, and divides so as to form those

two arteries, about one inch after it arises from the arch; the next is the LEFT CAROTID ARTERY going to the head; the third is the LEFT SUBCLAVIAN, going to the left arm. The roots of these three branches occupy a great part of the arch of the aorta.

### ARTERIA INNOMINATA.

The right carotid and right subclavian arteries arise from the innominata. The right subclavian goes off in a more direct course than the left; it is thought to receive the blood more fully; perhaps, also, it is rather larger than the left subclavian: but, at all events, there is something peculiar in the mechanism of the right arm; most probably it is the peculiar form or direction of this artery that gives to the right arm a superior dexterity and strength. When Horses are to be broken, we find the chief difficulty to consist in teaching them to move equally with both feet, for they prefer the right; when a Dog trots, or when he digs the ground, he goes with his right side foremost, and digs chiefly with his right foot; and in these creatures we find the same arrangement of these arteries as in ourselves. But in Birds, where an equal balance of strength is required for the wings, both subclavian arteries are distinct branches of the aorta. When we lose our arm, the left hand acquires by use all the strength and dexterity of the right. Since, then, either arm can acquire this dexterity, and since the right leg is stronger by its dependence upon the motions of the right hand, we have every reason to believe, that the preference given to the right hand has some physical cause, and that it is the peculiar form of this artery, viz. going off more directly on the right side, and that those who are ambidexter must have the right as well as the left subclavian going off as one independent branch.

There is another peculiarity which has occurred. This arch sometimes gives out four branches, and the left subclavian, arising first from the arch, has

passed behind the trachea, betwixt the trachea and the œsophagus. In a subject dying of difficult deglutition, which had subsisted from childhood, it was attributed to the pressure of this preternatural artery, an effect which I cannot easily believe; and it has been proposed to rank it as a new and certainly incurable species of disease, under the title of dysphagia lusoria, as arising from a lusus naturæ of this artery.

### LEFT CAROTID.

The next branch of the arch is the LEFT CAROTID. The two carotids mount along the sides of the neck, are felt beating strongly, and seem much exposed. They retire for protection behind the prominence of the thyroid cartilage. They divide into external and internal carotids under the angle of the jaw. The EXTERNAL CAROTID supplies the neck, the face, the inside of the throat; and the reader will have chiefly to observe its course all along the neck, its branching at the angle of the jaw, and the operations and wounds about the throat, neck, face, and especially about the root of the ear.

### LEFT SUBCLAVIAN.

The left subclavian is the third branch of the aorta. Each subclavian artery varies its name according to the parts through which it goes. This great artery of the arm is named SUBCLAVIAN under the clavicle, where it gives branches to the neck; AXILLARY in the arm-pit, where it gives branches on the one hand to the scapula, on the other to the breast. It is named BRACHIAL where it runs down the arm, and where there are few important branches; and, finally, its branches, into which it divides at the bend of the arm, are named RADIAL, ULNAR, and INTEROSSEOUS, because they respectively run along these parts, the radius, the ulna, and the interosseous membrane.

### THORACIC AND ABDOMINAL AORTA.

The aorta, after completing its arch, passes through the thorax, giving but few branches, and those very slender. But the ABDOMINAL AORTA, as soon as it has emerged from under the crura of the diaphragm, gives three great abdominal arteries: first, the CÆLIAC, going in three branches to the liver, the stomach, and the spleen; secondly, the SUPERIOR MESENTERIC, which furnishes all the small intestines; and thirdly, the LOWER MESENTERIC, which supplies most of the great intestines down to the rectum. The arteries of the kidneys and of the testicles follow these, and then the aorta divides into two great branches for the pelvis and legs.

The ILIAC ARTERIES are the two great branches into which the aorta divides within the abdomen, and these again are each subdivided into two great arteries; the INTERNAL ILIACS to supply the pelvis, the EXTERNAL ILIACS to go to the thigh.

### INTERNAL ILIACS.

The INTERNAL ILIAC supplies the bladder, the rectum, the womb, with lesser arteries; but its great arteries go out by the openings of the pelvis to supply the very large muscles of the hip and thigh. Thus the GLUTÆAL, a very great artery, turns round the bone, goes out by the sciatic notch, and goes to the glutæal muscles. The SCIATIC, almost equally large, turns down along the hip opposite to the glutæal, which turns up. The pudic, of great size, also turns out of the pelvis, turns inwards again towards the root of the penis, and belongs entirely to the private parts, as its name implies.

### EXTERNAL ILIACS.

The EXTERNAL ILIAC, when it passes out of the abdomen, takes the name of FEMORAL ARTERY: it divides into two large arteries a little below the ligament of the thigh: the one goes deep, belongs to

the muscles, and is called PROFUNDA ; it furnishes all the thigh, and it might with the strictest propriety be named the femoral artery. The FEMORAL ARTERY, as we call it, is the other great branch, which continues superficial, runs obliquely down the fore part of the thigh, gives few and but trivial branches to the thigh, and is really destined for the leg. When the artery turns inwards towards the ham, it is named POPLITEAL ARTERY ; and, like the artery at the bend of the arm, this one at the bending of the knee divides into three great branches, which, like those of the arm, take their names from the bones along which they run ; the ANTERIOR TIBIAL ARTERY lies on the fore part of the tibia ; the POSTERIOR TIBIAL ARTERY runs along the back part of the tibia ; the FIBULAR ARTERY runs along the fibula ; and these great arteries terminate by making arches with each other in the sole of the foot, in the same manner that the RADIAL and ULNAR ARTERIES join in great arches in the palm of the hand.

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This slight plan I have chosen to throw out before my reader, that the succeeding parts may seem more methodical, and that he may have at a slight glance the chief parts of his task before him ; and knowing all his duty, he cannot be inattentive to that on which the lives of his fellow-creatures must so often depend.

# OF THE ARTERIES OF THE HEAD.

## OF THE CAROTID ARTERIES IN GENERAL.

The carotid arteries are also named the Arteriæ Cerebri, as if they were the sole arteries of the brain; and the ancients, either ignorant or forgetful of there being any other arteries for the brain, or not observing that the vertebral arteries might convey blood enough for the functions of the brain, did actually name the carotids the Arteriæ Soporiferæ; believing that, if they were tied, the person must fall asleep.* How a person might die from having the great arteries of the head tied, I can most readily conceive; but how he should rather fall asleep, and not die, is quite beyond my comprehension: and yet many of the best anatomists, in the best age of anatomy, have abused their time repeating these experiments.†

* The name which we use, viz. that of carotids, is synonymous in Greek with Arteriæ Soporales.

† Valsalva, Van Swieten, Pechlinus, Lower, and especially Drelincurtius in his Experimenta Canicidia, and many others, spent days and weeks in tying up the carotids of Dogs. What does all this imply? Surely a strong belief in tales which would disgrace the Arabian Nights; tales concerning a manner of tying a cord round the neck of a She-goat, or even of a young Man, so that, without hurting them, they should be made to sleep or wake, according to the bidding of the spectators.

Costæus first tells this tale: "Circumforaneous mountebanks (says he*) often perform this miracle. They tie a ligature round the jugular veins of a She-goat; and they tighten it and relax it from time to time, so that at their pleasure the animal falls down motionless and stupid, and at their bidding leaps up again with great vigour." The most incredible tales soon followed, and soon crept into otherwise good and useful books. Even Hoffman seems not unwilling to believe that the Assyrians had been in use of tying up the jugular veins in their young men before circumcision, that they might feel less pain. A serious operation God-wot! for so

* Disquisitiones Pathologicæ, lib. 6. cap. 6.

Galen has explained it well, saying, "that physicians and philosophers, tying the carotid arteries, tie in along with them the recurrent nerves which serve for the voice; and if they will have silence to be sleep, no doubt the creature is mute after their awkward operation; but no other function is hurt neither then nor afterwards."

This is probably the whole truth; for if but one Dog lives after both carotids are tied, nothing can

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slight a cause. Even Morgagni talks more seriously of the She-goat, and of this snibbing of the young men of Assyria, than one could wish in respect to the character of one so truly great as Morgagni.* But the person the most celebrated in this affair was Realdus Columbus; and the wildest and most barefaced tale that ever was told, is that delivered by his pupil Valverda, in his Anatomy of the Human Body.

"The carotid arteries (says Valverda) being tied up, or any how obstructed, the person grows stupid, and falls presently into a profound sleep. This experiment I saw at Pisa in the year 1554. It was performed upon a young man by the celebrated Columbus in the presence of a great many gentlemen and strangers, with no less misery to them than amusement to us (the pupils), who, though we knew the cause, ascribed it altogether to the black art." But if any one word of this were true, Valverda would have told us, and been proud to tell us, by what particular operation, ligature, or pressure, this strange thing was performed; and Columbus himself, the author of this new amusement, would surely have dropped some hints about it in some place or other of his works. But from the modest silence of the master and the secrecy of the pupil, we have reason to believe it is untrue; and if Columbus did ever venture to exhibit such a mean piece of legerdemain, he put himself quite upon the level with the quack and his She-goat. The quack, indeed, was much beyond him in point of merit, since it must have been far easier to teach a clever young man to fall down or start up than to teach all this to a She-goat.

* The celebrated Cant not only believes this most powerfully, but reasons upon it in the following manner: "Ruffus Ephesius, lib. 1. cap. 34. hanc soporem adferre negat, hinc aliud nomen permitteret; sed Realdus Columbus publice in theatro demonstravit hunc effectum præstari hac arteria: itaque nomen retinebimus UTPOTE rei CONGRUENS. Sic enim quotidie experimur post prandium somnolentiam, quam facile deducere possumus ab effectu hujus arteriæ; nam ventriculo extenso premitur aorta descendens, quo sanguis copia majori ruit in carotides; quæ hinc extensæ comprimunt cerebrum quodammodo, quo motus animales non ita expedite absolvuntur, verum vitales augentur motus, quæ ambo fiunt in somno."—*Tab. Cant impetus faciens,* p. 6.

be more certain than that those which die must have suffered by some awkwardness or disease. Is it wonderful that, after such a cruel tedious operation as this is, the Dog should be exhausted, should be weakened by loss of blood, should feel sore, and hang his head and droop, and let the slaver fall from his jaws? that he should skulk in corners, look sidelong, be jealous, and not easily moved from his hole? These are what they have thought fit to call drowsiness and signs of sleep; but it is such drowsiness and such sleep as would have followed such a cutting up of the creature's neck, whether the experiment-maker had touched the carotids or not. The creature lolls its tongue, hangs its head, closes its watery and heavy eyes, is drowsy, or, in other words, feverish for many days: it eats with all the voracity of a Dog, but with difficulty, and slowly, owing to the swelling of its throat; and if it dies, it dies from the same cause. Nothing is more certain than that these are the only particular effects, and that the carotids of a Dog may be tied without any other danger than that of the wound.

There is nothing new under the sun. We are continually tantalized with old tales in new forms. Who would expect to find at this very day a practical application of the She-goat and the Assyrian young Men? One author has published to the world, "that a young Lady, of a nervous and delicate constitution, subject to nervous distresses in a wonderful variety of forms, but more especially in the head, sometimes afflicted with head-aches, sometimes with delirium, sometimes with convulsions, was relieved by compressing the carotid arteries." Often by compressing the carotid arteries, this gentleman prevented the delirium; "for all these complaints proceeded from a violent palpitation of the heart, with the stream of blood rushing violently towards the head." He has seen this compression bring on a stupor; he has seen it bring on a profound sleep. Is it not a pity that he had not attended more to the

history of this business, and joined to these facts the story of the She-goat and the young Men of Assyria?

If what Dr. Parry says be true, that in lean people, in women at least, we can, by reclining the head backwards, compress the carotids entirely against the fore part of the neck, with the finger and thumb; why, then, we need have no fear of hemorrhages of the nose, wounds about the jaw, cutting the parotid gland, or operations about the tonsils or tongue! But there is a dangerous mistake here; for there is (as I know by much experience) a wide difference betwixt preventing the pulse of an artery and suppressing the flow of blood through it. In the case of a Man fainting during any great operation, if you are holding in the blood with the point of your finger upon some great artery, you feel the pulse there, while the face is deadly pale, the extremities cold, and the pulse of the wrist and of all but the largest arteries, gone. In fainting, even the heart itself is not felt to move; and yet it moves, and the blood circulates: how else could a person lie in a hysterical faint for hours, I had almost said days? I have tried, in great operations near the trunk of the body, to stop the blood with my hands; but though I could suppress the pulse of the femoral artery with my fore finger, I could not command its blood with the whole strength of my body, but have seen it with horror rush as freely as if my hand had not been there.* In short, I suspect Dr. Parry's belief of his stopping the carotids with his finger and thumb is as vain as Dr. Monro's expectation of compressing the abdominal aorta by pushing with his fist against the belly.

The CAROTID ARTERY, having emerged from the chest, runs up along the neck by the side of the

* This is true, and we have all seen this splashing of blood from the ineffectual compression of the femoral artery, and yet it is certain that it may be compressed.—C. B.

trachea, a single undivided artery, without twig, or branch, till it is opposite the jaw. The length of this artery gives us a fair opportunity of observing, of proving, if we choose, that arteries are cylinders, and not as they once were supposed, of a conical form. But the cylindrical form of this artery should not occupy our attention so much, as that peculiarity of direction, which, though apparently exposed, keeps it safe; or those important connections and relations which are so necessary to know before tying it in the operation of aneurism, or when wounds have been received high in the neck and under the jaw.

The carotid artery, from the place where it emerges from the chest up to the angle of the jaw, is continually receding from the fore part of the throat, is getting deeper and deeper by the side of the trachea, at last the strong projection of the larynx or cartilaginous part of the tube defends it; and when it has got to the angle of the jaw, it lies there so deep under the ear, betwixt the ear and the jaw, in a sort of axilla, as we may call it, filled with fat and glands, that it is almost out of reach of danger.

The artery lies nearly parallel to the spine, though seeming to retreat from the projection of the throat. It lies deep, invested with its sheath. The omohyoideus crosses it. The sterno-cleido-mastoideus covers it.

The deeper situation of the carotid artery, as it ascends, and in reference to the larynx, saves it from the attempts of suicides: it is rarely cut, or when cut, it bleeds so that no ignorant person can command it, and the surgeon is too late. But although tumours and aneurisms are rare, and through unwillingness and a well-grounded fear such patients are usually left to take their fate; yet there may happen cases in which it may be necessary to do so bold a thing as to tie this artery.*

* I leave this as it was expressed by my brother in the first edition. The carotid artery has been often tied since this was written, and even by the author himself. It was with great pleasure

The connections of the carotid, as it rises along the neck, must determine our judgment, if ever any such case should occur. To stop the growth of an aneurism, to allow the extirpation of other tumours about the jaw, to save a patient from dreadful bleedings of the throat, or from the hemorrhages of deep wounds, when, for example, a patient is stabbed in the neck, or a ball passes through the mouth and under the angle of the jaw; these may, in some unlucky moment, present themselves as motives for tying the trunk of this artery, when all its great branches are torn. But always the observation of Galen is to be remembered, that the nerves accompanying these arteries are liable to be tied together with them.

Let us recollect how the carotid artery, jugular vein, and eighth pair of nerves, come out from the skull, for it is almost at one single point. The internal carotid artery enters by a hole in the temporal bone; the jugular vein comes out by a larger hole, betwixt the same bone and the occipital bone, the foramen lacerum; immediately behind it the eighth pair of nerves or the par vagum, goes out through a division of the same foramen lacerum, separated from the vein only by a little cross slip of the dura mater; and so the carotid artery, jugular vein, and eighth pair, touch each other at the basis of the skull. Through the whole length of the neck they continue the connection which is thus early begun, and are included in the same sheath. The par vagum being the great nerve of the viscera, at least of the heart, lungs, and stomach, strictures upon it or wounds are certainly fatal. It is therefore to be avoided with the utmost care in all operations performed in the neck, and especially in tying the carotid artery. — It lies in a division of the general

that I lately witnessed the cure of a soldier by the tying of the carotid. He had received a desperate wound with a sword, which entering in the neck came out at his mouth.—C. B.

sheath proper to it, rather under the artery, and betwixt the artery and vein.

When the common carotid has risen to the angle of the jaw, it divides into two great arteries, one going to the outside of the head, the other to the brain; the one of course named the EXTERNAL, the other the INTERNAL CAROTID. Some of the most eminent anatomists are incorrect when they say, that the carotid artery gives no branches till it arrives at the larynx. They say so because the first branch goes to the larynx; but, in fact, the carotid passes much beyond the place to which it is to give its first branch, for instead of branching at the larynx, it does not do so till it arrives at the corner of the jaw; there, as I have observed, it can, as in an axilla, lie deep and safe; and the laryngeal artery, which is the first branch of the carotid, turns downwards again to touch the larynx.

The first division, then, of the carotid artery is into the external and internal carotids; and the external carotid gives branches so interesting to the surgeon, yet so numerous, that it is at once very desirable and very difficult to get a knowledge of each: arrangement is here of more importance than in any order of arteries, though extremely useful in all.

## ARRANGEMENT OF THE BRANCHES OF THE EXTERNAL CAROTID ARTERY.

The external carotid gives three sets of arteries; each of which, having a plain and distinct character, cannot be forgotten, nor their direction, nor their uses, nor their relative importance, misconceived; for if we consider but the parts along which the carotid artery passes, as 1, The thyroid gland; 2. The tongue; 3. The face; 4. The pharynx; 5. The occiput; 6. The ear; 7. The inside of the jaws; 8. The temple: — if we remember thus the order of these parts, we shall not forget the order in which the branches go off.

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| BRANCHES OF THE COMMON CAROTID ARTERY. | 1. *Arteria Thyroidea Superior.*<br>2. *Arteria Lingualis.*<br>3. *Arteria Facialis.*<br>4. *Arteria Pharyngea.*<br>5. *Arteria Occipitalis.*<br>6. *Arteria Auricularis posterior.*<br>7. *Arteria Temporalis.*<br>8. *Arteria Maxillaris Interna.* |

1. The branches which go off from the carotid forwards are peculiarly important; one of them goes to the thyroid gland, another to the tongue, and a third to the face; parts which, to say no more, are peculiarly exposed; but they are, besides, the subject of many particular operations.

2. Those branches which go backwards and inwards, as the pharyngeal, the auricular, and the occipital arteries going to the ear, the pharynx and the occiput are both extremely small, and also run so deep, that wounds of them are rare and of less importance, and fortunately those branches are the only ones which it is difficult to remember.

3. The great artery which passes behind the lower jaw, named maxillary artery, and the temporal artery which lies behind the jaw, imbedded in the parotid gland, must be studied with particular care; the difficulty of cutting out tumours here, the course of the temporal artery in which we bleed, and which, lying imbedded in the parotid gland, demonstrates the absurdity of talking about cutting out the parotid gland, since plainly it cannot be done, without first tying the carotid itself, and then probably the operation would be fruitless, since a disease which had pervaded parts so deep would certainly return; and, lastly, the terrible hemorrhages which often happen from the throat, nose, tonsils, &c. give an importance to these two branches above almost any other. They should be very familiarly known to the surgeon.

### 1. ARTERIA THYROIDEA.

The THYROID ARTERY, often also named the upper laryngeal artery, comes off from the external carotid almost in the very moment in which it separates from the internal carotid. Its place is behind the angle of the jaw; it goes downwards and forwards in a very tortuous form, till it arrives at the thyroid gland, upon which it is almost entirely expended; but yet it gives some branches, or rather twigs, of which the following are the chief:

1. One superficial branch goes upwards to the os hyoides, and sends its twigs sometimes under, sometimes over the os hyoides: it belongs chiefly to that muscle and to that piece of membrane which joins the os hyoides with the thyroid cartilage, named musculus hyo-thyroideus. This branch is both long and beautiful; it meets its fellow of the opposite side with free inosculations; it supplies cutaneous twigs, and twigs to the platysma myoides.

2. A second superficial twig goes downwards to the lower part of the thyroid cartilage, where it meets the cricoid, and there gives little arteries to the mastoid muscle, jugular vein, and skin.

3. There is another branch which proceeds frequently enough from this second one: it belongs entirely to the larynx, for which reason the thyroid is often named the superior laryngeal artery: it dives immediately betwixt the cartilages of the larynx; it enters betwixt the thyroid and cricoid cartilages, carries in along with it a twig from the eighth pair of nerves; it gives its twigs to the epiglottis, and to all the small muscles which lie under cover of the thyroid cartilage, and which move the little arytenoid cartilages; and then passes outward emerging from the larynx, and appears again supplying the crico-thyroideus muscle.

The fourth branch of the thyroid is properly the main artery, or continuation of this branch into the

substance of the thyroid gland; it applies itself to the side of the gland, nourishes its substance by a great many small branches into which it is divided. These branches are all oblique, tending downwards and forwards. Their course is upon the side of the gland, because, indeed, the gland consists chiefly of two lateral lobes, and hardly any of the gland, or only a small portion crosses the trachea; consequently this artery does not inosculate so much with its fellow of the opposite side as with the lower thyroid, which comes from the subclavian artery, and whose branches, mounting upon the lower part of the gland, have pretty nearly the same degree of obliquity with those of the upper thyroid.

5. A branch of this runs across, and inosculates with the artery of the other side.

RECAPITULATION OF THE BRANCHES OF THE

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| Arteria Thyroidea. | 1. *Rami Musculares.*<br>2. *Arteria Laryngea.*<br>3. *Ramus Anastomoticus.*<br>4. *Arteria Thyroidea Propria.* |

## 2. ARTERIA LINGUALIS.

The LINGUAL ARTERY is one of which the four branches are nearly of an equal size, and which of course require all of them to be equally well remembered. It is next to the thyroid, comes off immediately above it, goes forward towards the os hyoides, runs directly above the extremity of the cornu of that bone, and towards the tongue; it lies flat upon the side of the tongue upon its flesh or muscles, and gives the following branches:

1. Upon passing the horn of the os hyoides, it gives first one twig of less note backwards to the constrictor pharyngis, at the place where that constrictor arises from the horn of the os hyoides (viz. the constrictor medius); and it gives another branch forwards round the basis of the os hyoides, where it meets its fellow, viz. ramus anastomoticus: and to

those who are acquainted with the muscles which arise from the os hyoides, it is needless to say what muscles it supplies.* This, which is named the RAMUS HYOIDEUS, seems to be very necessary, as it is a very constant branch; and when it does not come from the lingual, it infallibly arises from some other, commonly from the facial artery.

2. DORSALIS LINGUÆ is a branch which goes off from the lingual at the insertion of the stylo-glossus muscle into the tongue: it turns first outwards a little, and then inwards over the root of the tongue, where the arteries of the opposite sides meet, and form a sort of net-work. Its chief branches are directed backwards towards the epiglottis and mouth of the pharynx, amygdalæ, &c.

About the middle of the tongue, or about half way to the chin, measuring along the jaw, the lingual artery forks into two branches; the one below the tongue, the sublingualis, belongs to the sublingual gland and surrounding parts; the other remaining at the root of the tongue, belongs to the tongue itself.

3. SUBLINGUALIS then arises next; it comes from the side of the artery next the tongue; it runs under the sublingual gland, covered like it by the genio-hyoideus muscle, and emerges only when it arrives at the chin, where it terminates in the skin. Its branches are chiefly to the sublingual gland, which lies over it, and to the genio-hyoidei and mylo-hyoidei muscles and skin, for these are the parts which immediately cover it.

4. The ARTERIA RANINA is the larger branch of these two; it runs along the root of the tongue quite to the tip of it. In this course it is accompanied by its vein, which appears on the inside of the mouth when we turn up the tip of the tongue. This is the vein which the older physicians were so fond of

* Viz. the hyo-glossus, digastricus, mylo-hyoideus, the genio-hyoideus, the genio-hyo-glossus, sterno-hyoideus, and hyo-thyroideus.

having opened in sore throats; the artery is that which we are so apt to cut in dividing the frenulum linguæ; an awkwardness from which a great many children have died.

RECAPITULATION OF THE BRANCHES OF THE

ARTERIA LINGUALIS.
1. *Rami Pharyngei.*
2. *Ramus Hyoideus Anastomoticus.*
3. *Arteria Dorsalis Linguæ.*
4. *Arteria Sublingualis.*
5. *Arteria Ranina.*
6. *Rami Irregulares Musculares.*

### 3. ARTERIA LABIALIS, OR FACIALIS.

The labial artery is named occasionally the EXTERNAL MAXILLARY artery, to distinguish it from one which goes off at a higher point, and goes to the inside of the jaw; or ANGULARIS, because it goes to the corner of the mouth and there divides; or FACIALIS, implying, that it supplies the face, as indeed it does as far as the angle of the eye and forehead, where there are other small arteries. Haller adheres to this name of LABIALIS, and in compliment to him we adhere to it.

This artery is still carefully kept down in the deep angle; although it is to come out upon the jaw, yet it is not exposed till it actually makes its turn: it lies under the stylo-hyoideus and the tendon of the digastric muscle: it is very tortuous, that it may move along with the jaw, and lies still so deep, even when it approaches the jaw-bone, that it is forced to make a very violent and sudden angle when turning over it. This sudden turn, which is sometimes almost a circle, is made, as it were, in the heart of the great sub-maxillary gland, the artery being buried under it. The labialis is a very large artery, very tortuous; sometimes one great trunk gives off two important arteries at once, the lingual and the facial; in which case they separate just at the angle of the jaw, where the artery, dividing the substance of the

gland, is quite imbedded in fat. When we consider how deep this artery lies according to this general description, and the parts which it passes along, it becomes easy to foresee what branches it will give, and to trace them in imagination.

1. Where it lies the deepest upon the side of the pharynx, it sends a branch directly upwards, which goes straight to the arch of the palate, spreading its small twigs upon the arch of the palate, upon the velum palati, and upon the uvula: it usually has two small branches for supplying these parts, one superficial and one deep; and thus the labial gives a particular artery to the palate, named ARTERIA PALATINA INFERIOR.

2. It gives a particular artery to the tonsil, which arises at that point where the stylo-glossus begins to mix with the other muscles of the tongue. This little artery penetrates the walls of the pharynx upon which it lies, and spreads its many twigs upon the tonsil and tongue.

3. While passing through the sub-maxillary gland, dividing it, as it were, into two parts, the labial artery gives a great many small twigs into the substance of the gland itself; and after these it gives many twigs to the tongue, the skin, the muscles, &c. Of these, two chiefly are remarkable; one, which goes to the pterygoid muscle chiefly, though it also gives branches to the constrictors of the fauces and palate, and to the root of the tongue; and another artery, more constant and regular, which breaks off at the place where the labial artery curls and bends to turn upwards; it runs superficially, and goes straight forwards to the root of the chin, where it is named ARTERIA SUBMENTALIS: it turns upwards over the chin to the face at the middle of the chin, and often inosculates with some of the arteries of the face: it sometimes comes from the sublingual artery.

But the artery having emerged from betwixt the lobes of the sub-maxillary gland, (for this artery in a manner divides it into lobes,) and from among the

fat with which it is surrounded, makes a sudden turn over the angle of the jaw at that point where we feel it beating strongly; and then mounting upon the face, begins to give a new set of arteries.

1. A branch to the masseter muscle; for the labial artery passes over the jaw, and up the face, just at the fore edge of the masseter muscle; and this branch inosculates with a twig descending over the surface of the masseter from the temporal artery.

2. The labial artery ascending in the hollowest part of the cheek, and lying flat upon the buccinator muscle, gives out small branches to it, which inosculate chiefly with the transversalis faciei, another branch, and a considerable one coming from the temporal artery across the face. Here also the main artery has still a very serpentine line, on account of the continual motions of the part.

3. Before the artery comes to that point where it is to give off the coronary artery of the lower lip, it gives a branch named labialis inferior; which artery belongs to the lower part of the lower lip: its branches go to the triangularis and quadratus muscles, which lie on the chin and on the side of the chin, and also to the lower part of the orbicularis oris. This branch inosculates particularly with a twig, which comes from within the lower jaw through the mental hole, and with its fellow, and of course with the coronary arteries which run immediately above it, viz. in the red part of the lip.

The artery now divides into two branches, one for each lip, named the CORONARY ARTERIES, because they always surround the lips entirely, though their manner of going off is not perfectly regular. The lower coronary artery is usually smaller, and is to be named the branch, while the upper one not only surrounds the lip, but mounts along the side of the nose; it is larger; and is therefore to be considered as the continued trunk. We frequently observe the upper coronary larger on one side of the face, and the lower coronary larger on the other.

4. The LOWER CORONARY comes off about an inch or more from the angle of the mouth, at that point where the triangularis oris and many other muscles meet. It goes directly forwards to the angle of the mouth, enters into the lower part of the lip, and runs along the red pulpy part of it, where with the finger and thumb it can be felt beating. It inosculates with all the arteries formerly mentioned; as the submental, the twig which comes through the hole near the chin, the inferior labial artery, and with its fellow. With all these it inosculates so freely, that it signifies little from which side your injection is driven: it goes freely all round the lips, and the arteries are every where equally filled.

5. The UPPER CORONARY ARTERY we are to consider as the continued trunk. The labial artery is still rising, and still tortuous, when it arrives at the angle of the mouth; runs into the border or fleshy part of the upper lip, and runs along it till at the middle of the lip it meets its fellow of the opposite side, with a very free inosculation: yet the two arteries do not terminate here, but usually two very delicate arteries ascend towards the point of the nose, along that little ridge from the nose to the lip which we call the filtrum; and almost always a considerable artery runs up from the superior labial artery by the side of the nose. From this is given off a branch to the nose, viz. the NASALIS LATERALIS, and now the artery still ascending, (under the name of ANGULARIS,) gives off branches to the cheek and eyelids, and growing gradually smaller, it arrives at last near the angle of the eye, and inosculates pretty freely with the branch of the internal carotid artery, which is named ophthalmic, because it first nourishes the parts of the eye with many branches, and then comes out of the orbit at the corner of the eye, where, though small, it may be felt beating distinctly.

ARRANGEMENT OF THE BRANCHES OF THE

| | | |
|---|---|---|
| ARTERIA FACIALIS. | 1. *Palatina Ascendens.* | *Ramus Palatinus Superficialis.* <br> *Ramus Palatinus Profundus.* |
| | 2. *Ramus Muscularis.* | |
| | 3. *Ramus Tonsillaris.* | |
| | 4. *Ramus Pterygoideus.* | |
| | 5. *Arteria Submentalis.* | *Ramus Superficialis.* <br> *Ramus Profundus.* |
| | 6. *Ramus Massetericus.* | |
| | 7. *Arteria Coronaria Labii Inferioris.* | |
| | 8. *Arteria Coronaria Labii Superioris.* | |
| | 9. *Arteria Angularis.—from which Nasalis Lateralis.* | |
| | 10. *Ramus Anastomoticus Cerebralis.* | |
| | 11. *Ramus Frontalis.* | |

The *second* set of arteries, which go backwards from the external carotid, comprehend the pharyngeal, the occipital, the auricular.

### 4. PHARYNGEA INFERIOR.

The LOWER PHARYNGEAL * is a small slender artery, which gives no branches deserving to be numbered; it stands alone, and should be described as one simple artery, whose small branches spread all about the throat in the following manner.

This artery is smaller than any other branch of the carotid yet enumerated. It arises opposite to the lingual artery; and as it arises from the inner side, it comes out in a manner from the fork betwixt the external and internal carotid arteries; it rises upwards very slender and delicate: it lies deep in the neck, upon the fore part of the flat vertebræ, or rather lies upon the flat face of the longus colli muscle. † After rising in one slender artery, single, without branches or connections, it begins all at once to give twigs.

* It is named lower pharyngeal, to distinguish it from one which comes downwards from the internal maxillary.

† When dissected, it must be taken out in a manner from behind the œsophagus. The carotids must be raised outwards before it can be seen; for it lies under them, betwixt them and the throat.

First, It gives branches inwards to the throat; for one twig surrounds the lower part of the pharynx about the root of the tongue, and sometimes goes forwards along with the glosso-pharyngeal nerve into the tongue. Another twig goes to the middle of the pharynx, and wanders towards the velum palati, giving branches to the amygdalæ. And still another goes higher towards the basis of the skull; it also gives twigs to the velum palati, to the back of the nostrils, to the upper part of the pharynx where the upper constrictor lies, (viz. that which comes from the basis of the skull,) and it gives small arteries to nourish the basis of the skull; as, to the os sphenoides, to the cuneiform process of the occiput, to the point of the temporal bone, and to the cartilage of the Eustachian tube.

Secondly, It sends branches outwards to the mastoid muscle, to the jugular vein, to the ganglion of the intercostal nerve, and to the eighth pair; and one particular branch, very small and delicate, goes along conducted by the great jugular vein, enters together with it into the skull, and makes one of the arteries of the dura mater, but it is a very delicate twig.

In general, one artery only of the dura mater is known or mentioned; but we shall see, besides the great artery of the dura mater, lesser arteries entering to it by all the perforations at the basis of the skull. The pharyngeal actually terminates in the dura mater, passing through the foramen lacerum posterius, and sending also a branch in together with the jugular vein. The occipital artery also sends one with the jugular vein, one by the foramen mastoideum, and one by a small hole in the occiput. The temporal often sends one through by the hole in the back part of the parietal bone.

## 5. ARTERIA OCCIPITALIS.

The OCCIPITAL ARTERY is also a simple artery, distributing its twigs about the ear, over the occiput, and down the back of the neck, and having no branches of sufficient importance to be particularly marked.

It arises next to the pharyngeal from the back part of the carotid; and lying particularly deep, it not only is covered at its root by the other branches of the carotid, but is covered in all its course by the thick muscles of the neck, except just where it is passing behind the mastoid process.

At first the occipital artery lies close in among the bones, passing over the transverse process of the atlas, crossing the root of the great jugular vein, and passing under the root of the mastoid process so as to lie at this place under the belly of the digastric muscle. Still as it encircles the occiput, it passes along very deep under the bellies, first of the trachelo-mastoideus, and then of the splenius and complexus, and emerges only when it arrives at or near the middle ridge of the occiput; and, lastly, it rises with many beautiful branches over the back of the head, to meet the branches of the temporal artery.

In this course the occipital artery sends out the following branches:

1. Branches to the biventer, which lies over it, and to the stylo-hyoideus muscle; and there is one longer artery which attaches itself to the root of the mastoid muscle, and passes along that muscle to inosculate with the thyroid arteries or with the lower cervical arteries which mount upwards as this descends.

2. Next it gives like the pharyngeal, a small artery, which goes backwards along the jugular vein; and having entered by the foramen lacerum, attaches itself within the skull to that part of the dura mater which lies under the lobes of the cerebellum.

3. The occipital artery, as it passes under the ear, sends out to it a small posterior artery, which goes to

the little lobe of the ear, and creeps up along its posterior border.

4. At this point the occipital often gives another artery, which passes upwards behind the ear, and is named the POSTERIOR TEMPORAL ARTERY.

5. The occipital artery, as it passes under the trachelo-mastoideus and splenius, gives branches to these two muscles; and it sends out from betwixt the trachelo-mastoideus and complexus a long branch, (the *cervicalis*) which descends along the neck a considerable way; and after having further supplied the splenius, complexus, and also the deeper muscles of the neck, it terminates by inosculating with a branch from the axillary artery, which as it crosses the neck is named transversalis colli. This descending branch of the occipital inosculates also with the vertebral arteries through the interstices of the vertebræ.

Having pierced the belly of the complexus, the artery now rises over the occiput in small and beautiful arteries; the chief of which belong to the occipital belly of the occipito-frontalis muscle and to the skin: it finally ends in inosculations with the backmost branches of the temporal artery. But of these extreme twigs of the occipital, two are remarkable, because they pass through the skull to the dura mater; one through a small hole in the occipital spine, and one through that small hole, which is behind the mastoid process. Sometimes the hole is in the temporal bone, but more frequently in the suture which surrounds the back part of the temporal bone.*

RECAPITULATION OF THE BRANCHES

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|---|---|---|
| OF THE ARTERIA OCCIPITALIS. | 1. *To the Styloid Muscles and Jugular Glands.* | |
| | 2. *Through the Foramen Lacerum to the Dura Mater.* | |
| | 3. *Ramus Auricularis.* | *Ramus Temporalis posterior.* |
| | 4. *Ramus Cervicalis* | *Ramus Superficialis.* |
| | | *Ramus Profundus.* |
| | 5. *Arteria Occipitalis Propria Ascendens.* | |

* Viz. the additamentum suturæ squamosæ.

### 6. ARTERIA POSTERIOR AURIS.

The POSTERIOR ARTERY OF THE EAR is the smallest and least constant of all the arteries which go off from the carotid; for it is often wanting, or often comes from some branch, and not from the carotid itself; often from the occipital, sometimes from the pharyngeal artery; it can scarcely be reckoned as a regular branch of the carotid. This artery, also, like the pharyngeal and occipital gives out no distinguished branches which we need to mark; it chiefly belongs to the ear, it gives branches to the cartilage of the external ear, it sends a larger branch through the stylo-mastoid hole to the internal ear, and the rest of its twigs go to the integuments, or to the bones.

The POSTERIOR AURIS arises much higher than any of those arteries which have been just described; it does not come off from the external carotid till it reaches the parotid gland; or rather it arises where the carotid is plunged into the substance of that gland; it passes directly across under the styloid process, and over the belly of the digastric muscle, and then goes up behind the ear: in this passage it gives branches to the parotid gland, and to the biventer muscle, the parts on which it lies; next it gives a twig, which furnishes the root of the cartilage of the ear, and perforates the lowest part of the cartilage, so as to spread itself upon the drum of the ear; this branch is named ARTERIA TYMPANI.

Its next branch, the ARTERIA STYLO-MASTOIDEA, is the most remarkable, for it is of considerable size, enters the mastoid hole, while the portio dura, or great nerve of the face, comes out: it is a chief artery of the internal ear; for it gives branches, 1. to the tympanum, one of which beautifully surrounds the bony circle, and then spreads upon the membrane itself; 2. to the muscle of the stapes, to the semicircular canals, to the cells of the mastoid pro-

cess and its delicate vessels; which arteries, when well injected with size, paint the walls of the cavity of the tympanum, and of the semicircular canals.

The main artery having given off the arteria tympani and this stylo-mastoid artery, and having passed the stylo-mastoid hole, becomes properly the arteria posterior auris, rising behind the ear, and giving its branches to the skin and mastoid muscle, and to the muscle behind the ear, (posterior auris,) and to the bone and periosteum, chiefly about the mastoid process; then its small branches play round the back part of the concha or shell of the ear; and, lastly, the artery, still mounting behind the ear, ends in small twigs, which go to the fascia of the temporal muscle, and which, of course, inosculate above the ear with the temporal artery.

The *third* order of arteries includes the termination of the external carotid artery in the temporal and maxillary arteries, which is after the following manner:

### EXTERNAL CAROTID ARTERY—*continued.*

The artery having entered into the parotid gland, lies there absolutely imbedded in its substance; and of the two arteries in which it terminates, one passes directly through the substance of the parotid gland, emerges before the ear, mounts upon the temple, and is named of course the TEMPORAL ARTERY; it performs here in the temple the same office which the occipital does behind, viz. it supplies the pericranium muscles, and skin: all this is very simple. But the other branch, in which (since it is exceedingly large) one would say the carotid terminates, goes off from the temporal with a sudden bend, sinks very deep under the articulation of the lower jaw, terminates in a leash of branches at the back of the antrum Highmorianum, and there gives branches to the lower jaw, the upper jaw, the inside of the cheeks, to the temple,

(deep arteries which lie under the temporal muscle,) to the upper part of the pharynx, to the nostrils, and to various other parts: it is this artery too which gives off the chief artery of the dura mater. The description of so great an artery, so widely distributed, becomes both difficult and important.

### 7. ARTERIA MAXILLARIS INTERNA.

The INTERNAL MAXILLARY ARTERY turns off from the temporal artery while imbedded in the substance of the parotid gland, and about the middle of the upright branch or process of the lower jaw-bone. It passes betwixt the lower jaw-bone and the outer pterygoid muscle; it then goes forwards till it touches the back part of the antrum maxillare, and terminates in a leash of vessels betwixt the back of the antrum and the pterygoid process; and, finally, it ends at the spheno-maxillary fissure, or, in other terms, at the bottom of the socket of the eye, where it gives the infra-orbitary artery, and a branch to the back of the nostrils.

In all this course the internal maxillary artery is extremely tortuous: first, it rises with a high and round turn at that point where it goes off from the temporal artery; then it bends suddenly downwards, where it passes betwixt the pterygoid muscle and the jaw-bone; then, as it approaches the back of the antrum, it rises with a third bending, and continues rising with very great contortions, till it ends in small vessels at the back of the eye and nostrils.

Before this artery gives out its greater branches, which require to be marked with numbers, it very generally gives some small twigs, nameless, and of less note; as a small twig to the ear, and the glands around it, another which gets into the tympanum to the muscle of the malleus, and a branch of it sometimes goes into the skull by that hole named foramen ovale, by which a division of the fifth pair of nerves

comes out, and goes to that part of the dura mater which covers the sides of the sella turcica.

Of the larger branches which the internal maxillary gives out, the first is the ARTERIA MENINGEA, the great or MIDDLE ARTERY of the DURA MATER. It goes off from the maxillary just where it leaves the temporal artery. Sometimes before entering the skull it gives small branches to the pterygoid muscles, to the mouth of the Eustachian tube, to the os sphenoides, and sometimes through that bone to the dura mater; but the main artery passes through what is called the spinous hole, which is in the very extreme point or spine of the sphenoid bone: it is this artery of which the surgeon should be particularly aware, and which touches the parietal bone at its lowest corner in the temple, and spreads from that point all over the dura mater like the branches of a tree. But besides these, its chief branches, which spread thus upon the parietal bone, on its inner surface, it gives smaller ones, which go into the substance of the bone, or into the ear, and sometimes through the orbit into the eye. Thus first several smaller twigs go into the substance of the os petrosum to nourish it; the holes may be seen about the rough part, where the os squamosum and os petrosum are united; next two twigs enter into the aqueduct by the small hole on the fore part of the petrous bone, one keeping to the canal itself, the other going to the cavity of the tympanum, and to the inner muscle of the malleus; and, lastly, one or two small twigs pass through the outer end of the foramen lacerum into the orbit, and go to the lachrymal gland.*

The LOWER MAXILLARY ARTERY is a slender and curious artery, which belongs chiefly to the teeth of the lower jaw, and which runs all along in a canal within the jaw-bone. The internal maxillary proceeds nearly an inch before it gives off this branch;

* Sometimes the great and proper artery of the lachrymal gland, instead of arising from the ophthalmic or proper artery of the eye, arises thus from the artery of the dura mater.

and then, while lying under the pterygoid muscle, it gives off a long and slender artery, which enters the jaw-bone at that great hole which is betwixt the condyloid and coronary processes; then runs all along within the jaw-bone, surrounding each of the teeth with arteries at the bottom of each socket. About the middle of the jaw-bone it divides into two branches, which proceed together in the bony canal, till one of them emerges upon the chin at the mental hole, inosculating there with the arteries of the face, viz. the labial and submental arteries, while the other goes onwards to supply the roots of the fore teeth also, and to meet its fellow within the jaw-bone at the chin. The nerve for the lower jaw enters along with this artery; the vein of this artery accompanies it, but lies under it in a separate canal, though still in the same line. The artery itself, before it enters into the hole of the lower jaw, commonly gives twigs to the inner pterygoid muscle which covers the hole. Considering the size of this artery, we cannot wonder at profuse bleedings from the teeth, or rather from their sockets.

The PTERYGOID ARTERIES.—While the artery is thus crossing betwixt the jaw and the pterygoid muscle, it gives branches to the external pterygoid muscle, both into its substance and over its surfaces. The number of these pterygoid arteries is variable and unimportant.

Next, while the maxillary artery is passing in a contorted form under the zygoma, where the temporal muscle is lodged, it gives off two arteries, which are called the DEEP TEMPORAL ARTERIES to distinguish them from the proper temporal artery, the only one which we feel outwardly, and which is superficial. Of these two deep temporal arteries, one runs more outwards, viz. towards the ear, the other runs more inwards, viz. closer upon the bone; whence the one is called the DEEP EXTERNAL, the other the DEEP INTERNAL TEMPORAL ARTERY.

The DEEP EXTERNAL TEMPORAL ARTERY arises where

the maxillary is passing under or near the jugum; it is of course near the coronary process of the jaw-bone. This branch then passes along the tendon of the temporal muscle, and ends in that muscle, giving branches also to the external pterygoid muscle; it is a short artery, and not very important by its size.

The DEEP INTERNAL TEMPORAL ARTERY arises further forwards, viz. where the artery is close upon the back of the antrum; from which point, mounting directly upwards, it passes in the very deepest part of the temporal arch, viz. that which is formed by the cheek-bone. It is longer and more important than the outward branch, supplies the deepest and thickest part of the temporal muscle, mounts pretty high upon the temple betwixt the muscle and the bone, and often, where it lies behind the cheek-bone, it sends a branch through that bone into the orbit which supplies the fat and periosteum of the socket, and in some degree also the lachrymal gland.

The ARTERY OF THE CHEEK is a very regular artery, in so far as regards its destination, viz. for the cheek; but in its origin it is extremely irregular. It has not often the importance of coming off as a distinct branch from the maxillary; but comes off rather more frequently from some of its branches, as from the deep temporal artery just described, or from the alveolar, or infra-orbital arteries, which are presently to be described. This artery perforates the buccinator muscle, and is spent upon it, and upon the other muscles of the cheek, as the zygomaticus and levator labii; it ends, of course, by inosculations with the arteries of the face.

The ARTERY OF THE UPPER JAW serves much the same office with that of the lower jaw, viz. supplying chiefly the sockets of the teeth; whence it is named ARTERIA ALVEOLARIS. It is an artery fully as large as that of the lower jaw; it begins upon the back of the antrum Highmorianum, and runs round that tuberosity towards the face and cheek with very tortuous

branches. Its branches are distributed first to the buccinator and fat, which fills up the great hollow under the cheek-bone, and also to the cheek-bone itself, where it is connected with the jaw-bone. Secondly, Other branches perforate into the antrum Highmorianum by small holes, which are easily seen upon its back part, and some of these branches go into the sockets of the backmost teeth. Thirdly, A more important branch than any of these, the branch indeed from which it has its name of alveolar artery, enters by a hole into the substance of the jaw-bone, and goes round in the canal of the teeth, just as the artery of the lower jaw does, giving branches to each socket. The curlings of this artery upon the back of the antrum are very curious; and while its deeper artery furnishes the teeth, some of the superficial branches go to the gums.

The INFRA-ORBITAL is so named from the hole or groove by which it passes all along under the eye from the back of the nostril till it emerges upon the face. The infra-orbital, and the branch last described, viz. the alveolar artery, generally come off from the maxillary by one common trunk; the alveolar goes forwards and downwards by the back of the antrum: the infra-orbital mounts upwards, and enters the spheno-maxillary hole, or rather it comes off just at the spheno-maxillary hole, which is the great slit at the bottom of the eye. As the artery enters its proper canal at the bottom of the eye, it gives some twigs to the periosteum and to the fat of the socket; as it passes along its canal in the bone, one branch dives down into the antrum through the bone; for this plate of bone in which its groove runs, is at once the floor of the eye and the roof of the antrum; within the socket it gives twigs also to the deprimens oculi, and to the lower oblique muscle, to the lachrymal sac, or even to the nostrils; when it emerges from the socket by the infra-orbitary hole, it terminates in the levator labii and levator anguli oris, and in inosculations with the arteria buccalis,

labialis, and especially with the nasal branch of the ocular artery. This infra-orbitary artery is accompanied through the canal, and out upon the face, with a small nerve of the same name, viz. the infra-orbitary nerve.

After this, the maxillary, though nearly exhausted, still sends out three small arteries, in which it terminates irregularly, sometimes one, sometimes another twig being larger. Of these three, one goes to the palate, one to the pharynx, one to the nostrils.

The UPPER PALATINE ARTERY arises near the infra-orbital; and from that point, viz. the spheno-maxillary slit, it descends along the groove, which is formed betwixt the pterygoid process and the palate-bone; and when it has gone down to the palate, one lesser branch turns backwards through the posterior palatine hole, and expands upon the velum palati; the other larger branch is the great palatine artery, for it comes through the anterior or larger palatine hole; the artery itself is large, it runs all along the roof of the mouth betwixt the pulpy substance of the palate and the bone; in this progress it gives little arteries to the sockets of the teeth, and it frequently terminates, not merely in the palate itself, but in a small artery which runs up through the foramen incisivum, or hole under the fore teeth, into the cavity of the nose. This artery is also accompanied with a corresponding palatine nerve.

The UPPER PHARYNGEAL ARTERY is the highest of all the branches of the internal maxillary; it goes off at the back of the orbit, opposite the spheno-maxillary fissure; it ascends along the sphenoid bone to the place of the sphenoidal sinus, and along the upper part or arch of the pharynx, where that bag adheres to the basis of the skull; it also goes along the sides of the pharynx: its twigs are of very diminutive size; some go into the substance of the sphenoid bone to nourish it by small holes both over the cells and in the alæ; a branch goes towards the ptery-

goidean or vidian hole*, where it inosculates usually with a branch from the internal carotid artery, sometimes with the lower pharyngeal, or with the meningeal arteries.

This artery ends in small branches which play round the mouth of the Eustachian tube.

The NASAL ARTERY is the last branch of the internal maxillary. It passes through the spheno-palatine hole†; by this opening it comes into the nostril at its upper and back part; the twigs go, one shorter to the backmost of the æthmoid cells, another to the cells of the sphenoid bone; one longer branch goes to the back part of the septum narium; and one branch, the longest of all, often passes both the upper and lower spongy bones, (along the lining membrane of the nose, giving twigs to the antrum as it passes,) till it inosculates with that twig of the palatine artery which rises through the foramen incisivum into the nose. This nasal artery often has two branches.

These branches are so numerous, and so small, that they require recapitulation.

MAXILLARIS INTERNA.
1. *Ramus Auricularis.*
2. *Arteria Meningea Media.*
3. *Arteriæ Parvæ.*
4. *Arteria Maxillaris Inferior.*
5. *Arteriæ Temporales Profundæ.*
6. *Arteria Alveolaris.*
7. *Arteria Infra-Orbitalis.*
8. *Arteria Palatina Maxillaris.*
9. *Arteria Pharyngea.*
10. *Arteria Nasalis.*

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* This is the hole by which the recurrent of the 5th pair goes backwards from the nose into the skull.

† Observe, this is not the spheno-maxillary slit so often mentioned, which is a slit-like opening lying between the wing of the sphenoid bone and the upper jaw-bone; and, as it is at the bottom of the socket, whatever parts enter it go to the eye. The spheno-palatine hole is betwixt the sphenoid and palate bones; it is at the back of the nostrils, and the branch which enters it belongs to the nostril.

## 8. ARTERIA TEMPORALIS.

The TEMPORAL ARTERY, if we consider its straight direction, may be regarded as the termination of the external carotid artery. When the maxillary artery bends away from it to go under the jaw, this goes directly forwards through the substance of the parotid gland, mounts before the ear; and as it passes alternately the parotid gland, the face, the ear, it gives its three chief branches to these parts, and ends in that temporal artery which runs along the side of the head under the skin, which we feel, and even see distinctly, beating, and which we open when bleeding in the temples is required.

The temporal artery is named SUPERFICIAL, because of its lying under the skin only, above the fascia of the temporal muscle, while the deep branches from the maxillary artery lie under the muscle.—The temporal artery passes just before the meatus auditorius, and behind the branch of the jaw-bone; it pushes its way through the substance of the parotid gland, and there it gives its first branches, commonly seven or eight in number, but quite irregular, into the substance of the gland itself; next it gives off to the face an artery of very considerable size; which arises from the same part of the artery with these parotideal branches, viz. under the zygoma and within the gland: like them it goes off almost at a right angle, and is like one of them, but larger, nearly of the size of a crow-quill; it pushes sideways through the substance of the parotid, emerges from it upon the face just below the cheek-bone; runs across the cheek in the same direction with the parotid duct; it is named from this direction TRANSVERSALIS FACIEI. Its branches go to the joint of the jaw-bone, the masseter, buccinator, parotid gland, &c. and terminate in inosculations with all the arteries of the face.

Next the temporal artery, as it rises towards the zygoma, and of course approaches the angle of the

jaw, gives an artery which is proper to the articulation of the jaw. This artery belonging to the joint of the jaw, is often named ARTERIA ARTICULARIS. After having sent its two branches to the articulation of the jaw, it sends another artery to the ear, which divides into two twigs; one of them going round the back part of the ear, assists the branch of the stylo-mastoid artery in forming the little circular artery of the tympanum; while another branch, penetrating through the slit which is in the articulation of the lower jaw, goes to the muscle of the malleus.

But before it reaches the zygoma, the temporal artery gives another branch, which is named the MIDDLE TEMPORAL ARTERY, to distinguish it from the deep temporal arteries which lie under the whole thickness of the temporal muscles, and the superficial temporal, which lies above the fascia; for this middle temporal artery lies under the fascia; but on the outside of the muscle it arises from the main artery just under the zygoma, rises over the zygoma, and then pierces its way under the fascia of the temporal muscle, and under that covering gives branches to the temporal muscle, the artery itself still rising and passing obliquely forward towards the outer corner of the eye, where one of its twigs often goes to the orbicularis oculi, and inosculates with the ophthalmic artery.

About this point, or rather above the zygoma, the temporal gives off those small arteries, irregular in number, which are named ANTERIORES AURIS, the anterior arteries of the ear, and which play all round the fore part of the ear.

The temporal artery having now emerged from the parotid gland, and from the thick fascia which covers it, makes a sudden serpentine turn before the ear; and then rising about half an inch perpendicularly, it forks with a pretty wide angle into two arteries, which are named the anterior and posterior temporal arteries. These lie quite superficial under the skin, above the fascia, and are distributed in this

manner: First, the ANTERIOR TEMPORAL ARTERY goes directly forwards to the naked part of the temple, runs up the side of the forehead with a very serpentine course; it is here that in old men we see its contortions and pulsations very distinctly; it goes round arching forwards, and upwards from the temple towards the top of the head. It belongs chiefly to the skin and frontal muscle, and that tendinous kind of sheath which covers the cranium; it gives some branches to the orbicular and corrugator muscles; it forms often a superciliary arch with the proper frontal artery; it often sends off a branch very early towards the outer corner of the eye, which is entirely destined for the orbicularis oculi.

The POSTERIOR TEMPORAL ARTERY is the last branch of all. It arches backwards over the top of the ear; it turns thus backwards till it meets the branches of the occipital artery; it deals it branches from either side upwards and downwards, *i. e.* towards the ear, and towards the top of the head in great profusion, till it is quite exhausted. These branches belong to the skin chiefly and to the pericranium; and the smaller twigs pierce the outer tables of the skull, and go into the bone in great profusion for its nourishment.

RECAPITULATION OF THE BRANCHES OF THE

TEMPORALIS.

1. *Ramus Massetericus.*
2. *Arteria Transversalis faciei.* { *Comes Ductûs Salivæ.*
3. *Arteria Temporalis Subfascialis.*
4. *Rami Auriculares.*
5. *Arteria Temporalis Anterior.*
6. *Temporalis Posterior.*

## CONCLUSION.

It would surely be wrong to conclude the description of a system of arteries so important as this, without attempting to interest my reader in this piece of anatomy, by observing a few anatomical and surgical facts.

It is natural to observe, as a thing which may pre-

vent confusion in the student's mind, how irregular (after all our attempts at arrangement) the smaller arteries unavoidably must be; how natural it is that each particular part should draw its blood from all the arteries which are near or round it. The ear has its posterior artery peculiar to itself; but it has also an anterior artery from the temporal, where it lies under the parotid gland; and it has even a superior auris from that branch of the temporal artery which bends round towards the occiput, and arches over the ear. The dura mater has its great middle artery appropriated to itself, a peculiar branch, the first of the maxillary artery; but it has besides small assisting arteries, entering by almost every point at the basis of the skull; and especially it has arteries from the maxillary, by the mouth of the Eustachian tube, from the pharyngeal, running in by the hole for the great jugular vein; and from the occipital both by the hole of the jugular vein in the basis of the skull, and also by the small occipital hole in the back part of the skull, close by the temporal bone. The throat also, though it has many peculiar arteries, derives its branches from a great many sources; as from the lingual artery by twigs, which cross the root of the tongue; from the labial artery by branches, which go to the tonsil, tongue, and palate; from the pharyngeal artery, many branches not confining themselves to the pharynx, stretch forwards to the palate, tongue, and tonsils; and, lastly, the maxillary artery gives a profusion of branches to all parts of the throat. These may serve as hints by which the student, if he wishes to become a correct anatomist, may trace the inosculations; or for the surgeon, if he wishes to separate the study of this minute anatomy from that of the greater arteries.

But there is a circumstance which may guide the student in the study of the arteries, the confusion or intricacy of branches arises from our manner of counting them off from the trunks; now the manner of the branching varies, whilst there is no variety in the

place of any artery, or the manner of its final distribution.

The thyroid artery, or the lingual artery, may come off separately, or together, but they never vary in their exact place; their relation to the thyroid cartilage, or to the cornu of the os hyoides, or to the muscle or the nerve, is invariably the same; some advantages might be had, by arranging the arteries according to their destination, instead of their departure in succession from the trunk; but the latter mode gives so great a facility to the learner, that we shall not depart from it.

The surgeon's interest in understanding these arteries is very strong. It were impossible to enumerate all the various occasions on which this piece of anatomy may be useful; but, surely, one may easily say enough on this subject to attach the young surgeon to the diligent study of these arteries.

Among the various motives for diligence, I would mention these: the terrible hemorrhages which he is daily called to stop, when suicides, though they have not cut the carotids, have cut the great arteries of the thyroid gland; the necessity of thinking about the tumours of the gland itself, for I have had the unhappiness to see a person perish by suffocation, while consulting-physicians forbade any operation; and I had no other than the melancholy privilege of watching, for many hours, the last struggles of a person, who had the day before been walking through all the rooms in tolerable ease and health. Could nothing have been resolved on? Must we always submit to this? Might not an incision in the fore part (where few arteries are) have at least uncovered the trachea, given a temporary relief, and made the tumour suppurate more freely? The extirpation of the tongue, which is mentioned with horror, would be a less terrible operation to one acquainted with these arteries; the extirpation of all tumours under the jaws is dangerous; the cutting out completely the parotid gland is a thing quite impossible, since

the greatest of all the arteries, viz. the temporal and the maxillary, lie absolutely imbedded in the gland. What shall we think, then, of those surgeons who talk in such familiar terms of cutting out the parotid gland? Bleedings from the nose have been so often fatal, that Petit is celebrated to this day for a discovery which he never made, viz. the way of plugging the nose so as to stop this bleeding. Have not the French Society been busy renewing inventions for securing even so small an artery as that of the dura mater? In the hare-lip operation, in cutting cancers, in dissecting tumours from all parts of the face, the surgeon commands the blood only by knowing these arteries. Cowper, the celebrated surgeon and anatomist, had his head so full of this project, that instead of waiting for hemorrhage during his operation, he cut off two days before the chief source of the blood. He was going to cut out the parotid gland; and two days before he placed a small button of caustic on each side of the labial artery, where it lies upon the cheek, passed a ligature under it, tied it firm, and then proceeded to his operation next day. But this great anatomist made at one stroke two grievous blunders: he missed, for want of knowledge, the chief arteries of the parotid gland, for they come from the temporal artery; and, if I mistake not, he had tied the vein, for most assuredly it is the facial vein which he is describing in his twelfth table from Bidloo. How terrible the extirpation of tumours from the gums, throat, tonsils, &c. is, I need not say; where the surgeon always uses burning irons instead of needles, where not unfrequently the patient dies.

# OF THE ARTERIES OF THE BRAIN, SPINAL MARROW, AND EYE.

## OF THE ARTERIES OF THE BRAIN.

The internal carotid arteries are named the arteriæ cerebri, as being the chief arteries of the brain; while, in truth, the brain is also supplied by two other arteries nearly equal in size, viz. the vertebral arteries, which though they do indeed arise from a different trunk, viz. the subclavian artery, yet are so entirely destined for the brain, give so few branches before they reach the skull, are so important when they arrive there, and above all make so large a communication with the carotid arteries, that without a description of the vertebral arteries, any description of the carotids must be defective; they unite so with the carotids as to form but one great system of vessels for supplying the brain.

The two greatest functions of the animal body, those of the womb and of the brain, the one for the life of the individual, the other for the continuation of the species, are the most liberally supplied with blood. The womb has on each side two arteries; it has two spermatics, and two hypogastrics, and the inosculations of these vessels are very large and free. The brain has two great arteries on each side; it has two carotids, and two vertebral arteries; they are infinitely larger than those of the womb; their inosculations are so particular, that there are no others like them in all the body: the injection of any one artery easily fills the whole; the preservation of but one artery saves the life of the creature, when the others are stopped.

These four arteries alone convey to the brain the fifth part of the whole mass of blood. This is the calculation made by Haller; and even those who would settle it at the lowest point still acknowledge,

that the carotid and vertebral arteries receive at least the tenth part of all the blood of the body. The brain then which weighs not a fortieth part of the whole body, receives one tenth of all the blood; a proportion which must occasion surprise.

Besides the profusion of blood which thus rushes into the brain, the impetus with which it forces its way seems dangerous; and Nature also seems to have provided against the danger. We cannot be but sensible of this danger; for the slightest increase of velocity occasions strange feelings, if not absolute pain. We cannot run for any length of way, nor ascend a stair rapidly, nor suffer a paroxysm of fever, nor, in short, have the circulation quickened by violent exertions, by emotions of the mind, or by disease, without feeling an alarming beating within the head; we feel it particularly in the carotid canal where the artery passes through the bone. If it continue from disease, or if we persist in our exertions, giddiness, blindness, ringing of the ears, come on. Haller remembers, that while he was lying in a bad fever, he suffered so much from the pulsations of the carotid artery within the skull, that his head was lifted from his pillow at every stroke. I wish he had said, "seemed to be lifted from his pillow at every stroke;" for it was rather a sickly feeling than what could actually happen.

Did this vast column of blood rush directly into the brain, we do not know what might be its effects; but surely they could not be harmless, since Nature has provided against it in man, and in the lower animals which hang their heads, with a peculiar care. In Man, this blood is retarded chiefly by the tortuous course which the artery is obliged to follow,* and by that long bony canal which, by holding the carotid as in a sheath, must suppress its violent action, and at least prevent its being dilated by force of the blood, when, as often happens, the lower part of the artery

* Although this be true, still the subject is pursued further when speaking of the circulation of the blood through the arteries.—C. B.

is more full and tense. Perhaps also it may have some effect, that the carotid, as it lies by the side of the sella turcica, is not naked and free, but is inclosed in a venous sinus, which consists of cells like those of the male penis, and in the heart of which the carotid lies.

It is also peculiar in all the arteries of the brain that they do not enter in trunks into its substance. This seems to be a violence which the soft texture of the brain could not bear; but all the arteries having perforated the dura mater, attach themselves to the pia mater, a delicate membrane, which is the immediate covering of the brain; which follows all its divisions, lobes, and convolutions; which enters all its cavities, and lines its internal surfaces as it covers the external. To this membrane of the brain the arteries attach themselves: it conducts them every where along the surface of the brain, and into its cavities; and when the arteries are to enter into the substance of the brain, they have already branched so minutely upon the pia mater, that they enter into the pulpy substance in the most delicate twigs; so that having injected the brain, at whatever level you cut into it, you find its white surface dotted with red points regularly, and like the dots of a pin.

But in the lower animals, especially in the Calf, the Deer, the Sheep, which hang their heads in feeding, there is a provision of so singular a nature, that we can have no doubt that these contortions of the great trunks and minute divisions of the smaller arteries in Man have the same final cause; for in those creatures the carotid, before it enters the brain, first divides into innumerable smaller arteries. Not one of these is sent off for any particular function; they are immediately reunited again, and gathered together into one trunk; and then the force of the blood being thus broken, the artery divides a second time into branches of the ordinary form, which enter safely into the substance of the brain.

It is still further supposed, that the arteries of the

brain have this peculiarity, distinct from all others in the body, that as they enter the skull they lay aside one of their coats, and that of course the arteries of the brain are peculiarly weak. That the arteries of the brain want that outward coat of cellular substance which all arteries passing through other cavities or along the limbs have, is no doubt true, and so far they are thinner: but how much they are weakened by this loss, it is not easy to say; for they want none of the coats which are essential to the constitution of an artery; and this cellular coat, though it constitutes much of the thickness of an artery, has, I believe, but little to do with its strength. Yet true it is, that the arteries of the brain, either from being weaker in themselves, being less supported, lying upon the soft and pulpy substance of the brain, are more frequently burst by falls, or even by the slightest accidents, than the arteries of any other part, even the limbs, however much exposed. Our injections burst them very often; the slightest blow or fall upon the head often produces an internal effusion of blood, which occasions death; but that the arteries of the brain are so delicate as to be burst by a false step so as to produce a fatal aneurism within the brain, is a truth perhaps not commonly known.

A young woman, carrying in her arms her first child, about six months old, slipped her foot with a slight shock; but it was on plain and even ground, and she did not fall down. In the instant of this shock she was sensible of a sudden pain in the right side of her head: it was so peculiar, that she said she could cover the point with her finger; and though slighter at intervals, this pain never left her to the moment of her death. She walked home, went about her little family matters, suckled her child; but was seized that evening with sickness, not violent like that of any sudden disease, but rather like the easy vomiting of a pregnant woman.

She continued very sick, with slight head-ach; but still was out of bed all day long, went about her

household affairs, and had no symptom which could lead one to suspect her very dangerous condition, or what a dreadful accident had happened. She got up during the night after this accident for some cool drink, felt herself extremely giddy, was obliged to support herself by a chest of drawers which stood by her bedside, and went to bed again immediately. On the evening of the second day she got out of bed, made tea as usual, was out of bed during the evening, had no complaint, except the continual sickness, slight pain of the head, and giddiness still slighter. That night she expired. Her pulse all along had beat low and weak, and never more than 60 in the minute.

When I was brought to open the body, I heard nothing of the pain of her head, though it was fixed and constant, and without that nothing could be more puzzling than this combination of circumstances. First, the sudden slipping of her foot, and the incessant sickness which ensued, suggested the idea of hernia; but no such secret was known among her relations; and upon opening the abdomen, no hernia was found, neither open nor concealed as in the thyroid hole.

Next we were informed of a palpitation, which had been usual with her. It appeared that she had complained chiefly about the period of her first menstruation, and some years before her marriage. It seemed to be hysterical merely; but upon opening the thorax, we found the heart wonderfully enlarged and crammed with a dark and grumous blood.

But next a new scene opened upon us; and this enlargement of the heart appeared to arise like that of the liver, which so often accompanies fractured skull, from the languid action of the heart and torpor of all the system in those who lie even for a few days comatose.

Now, for the first time, I was informed that the shock of slipping her foot had caused a sudden pain of the head; that it was pointed, confined to one single spot, incessant, accompanied with perpetual

vomiting, or desire to vomit, and with giddiness during the night.

Upon opening the head, I found the dura mater of a most singular appearance; livid, or rather like the gizzard of a fowl, with green and changing colours. Having cut it open, the pia mater appeared like red currant jelly, with fresh coagulated blood so firmly attached to it, that it seemed as if driven into its very substance, and incorporated with it. Upon cutting and tearing open the pia mater, each convolution of the brain was surrounded and separated from that next it by coagulated blood. Upon cutting into the ventricles of the brain, that of the right side was found to contain four ounces of entire and coagulated blood; the cavity at first view was like opening a ventricle of the heart; the blood, very dark and firmly coagulated, was forced out by the pressure of the surrounding parts; the coagulum became gradually firmer and whiter, till it turned to a very firm stringy clot, which stuck in the mouth of the middle artery of the brain. Being carefully examined, it was found to be sticking firm in the mouth of the artery which had burst, as if by the separation of two of its rings. The blood, which thus filled the right ventricle, had also made its way down in prodigious quantity into the third and fourth ventricles, quite into the occipital hole; but the opposite ventricle it had not filled. *

The quantity of blood ascending to the head is exceedingly great; its free circulation in all the arteries is perfectly secured; and the plan of its distribution is extremely simple, for the carotid entering by the os petrosum, gives three branches. First, a branch

* This case is preserved here as an example to the reader of the manner in which Mr. John Bell narrated his cases. Were the subject to be pursued, many other cases of rupture of these arteries might be given, not certainly tending to confirm the ideas inculcated here. I doubt very much if life can continue so long after the rupture of this artery, and I am rather inclined to believe, that the artery was ruptured in the night of the young woman's death.

which unites the two carotids with the two vertebrals, and forms the fore part of the circle of Willis. Secondly, it gives an artery to the great middle lobe, whence it is named the great middle artery of the brain. Thirdly, an artery which is named anterior cerebri, as belonging to the fore part of the brain. But the vertebral, as it arises through the occipital hole, lies upon the cerebellum, and supplies all the cerebellum, and also the back part of the cerebrum. One branch goes to the back part of the cerebellum, another to the fore part of the cerebellum, a third branch goes to the back part of the brain; and thus there is formed betwixt the carotid and the vertebral, by means of the great inosculation of the circle of Willis, one great set of vessels; which should first of all be described free from all the interruptions of trivial arteries, which go off from point to point, but of which the destinations cannot be important, which are hardly known, which do not go in any two subjects the same way.

## OF THE INTERNAL CAROTID ARTERY.

The internal carotid artery leaves the external carotid at the angle of the jaw: it is so inclined to contortions, that at this point it bulges, and even seems the outermost of the two. In mounting along the neck, it is tied by cellular substance to the fore part of the rectus or straight muscle of the neck, and it is also connected with the par vagum and intercostal nerve: the ganglion of the intercostal, or sympathetic nerve, lies by its side; the nerve, before it forms this ganglion, comes down small and thread-like through the same canal by which the carotid passes into the skull.

The contortions of the carotid are great, both before and after its passage through the bony canal; but within the canal it is forced to particular and successive bendings, such as indicate plainly some design of Nature; for the canal for the artery is long

and tortuous, while the nerves and veins pass through plain and simple holes. When the carotid first presents itself to enter the skull, it is curved, and is a little behind its hole ; it bends forwards and inwards a little, and so enters the canal; in entering the canal it rises almost perpendicularly upwards, but soon bends forwards again, lying, as it were, upon the floor of the canal ; then it bends again upwards and forwards, to emerge from the canal ; by which turn the portion of the artery which is engaged in the canal has the form of an Italic *ſ*. Even after it gets into the skull, it must still bend once more sideways and forwards, as if to meet its fellow, and to get to the side of the sella turcica ; then it goes directly forwards till it touches the anterior clynoid process ; and then doubling back, or returning upon itself, it rises perpendicularly ; and so perpendicular is this last turn, that when cut across, the mouth of the artery gapes perpendicularly upwards : here it begins to give its branches to the brain.

It is by the side of the sella turcica that the CAVERNOUS SINUS surrounds the artery. This sinus is formed by the two plates or lamellæ of the dura mater, parting from each other, and leaving an interstice full of cells, like those of the penis or of the placenta. It is filled with blood, by communication with several of the smaller sinuses or veins about the basis of the brain ; the ophthalmic veins bring into it the blood from the eye ; four or five small veins descending from the fossa Sylvii bring blood into it from the middle parts of the brain ; the sinuses of the os petrosum (both on its upper and lower grooves) open into it, one high, another lower down, and that circular sinus or vein which surrounds the root of the optic nerves, opens into it from either side. All this blood is poured into the cells ; the internal carotid artery rises through these ; and by the side of the carotid artery lies also that small nerve of the sixth pair which is connected with the great intercostal nerve.

Veussens first discovered this curious structure; Ridley denied it, and Haller at last in his turn confirmed it. Veussens believed that the sinus which deposited this blood conveyed it away again. Haller says that this is the peculiar office of that vein which accompanies the carotid artery, and which is named the vena sodalis arteriæ carotidis. It was once supposed that certain small arteries opened also into the sinus; but it has neither arteries nor pulsation.

Thus we trace the carotid through its canal, through the cavernous sinus, up to the side of the sella turcica, and about to enter the brain, to give off the arteries of the brain. But before we describe these, it will be easy to count shortly those little twigs which it gives off in the canal and in the sinus.

The carotid artery seldom gives out arteries before it enters the skull; it is a lusus naturæ, when it does happen that the occipital or pharyngeal arteries come off from it.

The first twig, which in any case it gives off, is sometimes a small artery, which returns downwards along with the upper maxillary nerve *; next, a small twig, accompanied by a branch from the meningeal artery, goes into the tympanum by way of the aquæductus Fallopii; and next, while the artery is within the sinus cavernosus, it gives out two little branches, the one forwards, the other backwards, named ARTERIES of the RECEPTACULUM.

1. The little artery which goes backwards from the sinus or receptaculum goes chiefly to that part of the dura mater which covers the posterior clynoid process, and which covers the cuneiform process of the occipital bone; it gives twigs to the 4th, 5th, and 6th pair of nerves, and to the pituitary gland; in short, to all the parts at the back of the sella turcica; it ends in inosculations with those twigs of the vertebral artery which come off from the vertebral before it enters the skull.

* The second branch of the 5th pair.

2. The little artery which comes out from the receptaculum to go forwards, arises where the carotid is crossed by the 6th pair, and has been confounded with a delicate nerve which joins the intercostal nerve to a branch of the 5th pair. The distribution of this little artery is nearly the same with that of the first, for it belongs to the 3d, 4th, and 5th pair of nerves, and to the pituitary gland.

The carotid having risen to the anterior clynoid process, gives out there a small artery, less than a crow-quill, which enters directly into the orbitary hole, accompanies the optic nerve into the eye, furnishes the eye, the eye-lids, the muscles, and the lachrymal gland, and sends out branches upon the forehead, viz. the frontal arteries in which it ends. This is a short history of the OPHTHALMIC ARTERY; which, as it furnishes all the arteries of the eye, must be described apart.

## DIVISION OF THE INTERNAL CAROTID.

The carotid, now about to enter into the brain, divides at the sella turcica into three arteries; one to the fore lobe, another to the middle lobe, and a third to form the circle of Willis. These arteries are usually so numbered that the communicating branch is first described; next, the anterior artery of the brain; and, lastly, the middle artery of the brain. But of this arrangement no one who is accustomed to observe the course of this artery can entirely approve; for when the carotid rises from the side of the sella turcica, it divides into its three branches all at once, in a tripod-like form: the middle branch of the tripod is largest; the next, which goes forwards to the fore lobe of the brain, is smaller; the third, which is the communicating branch, going backwards to unite with the vertebral artery and form the circle of Willis, is the smallest of all. The middle artery of the brain then is, from its great size, to be regarded as the trunk.

## 1. ARTERIA MEDIA CEREBRI.

The middle lobe of the brain is separated from the anterior lobe by a very deep sulcus or furrow, which is named FISSURA SYLVII. This fissura Sylvii is formed by the transverse process of the sphenoid bone, or, in other words, by that very sharp line which runs out laterally from each of the anterior clynoid processes, and which parts the fore lobe, which lies in the shallow part of the skull upon the orbitary processes of the frontal bone, from the middle lobe, which lies in the deepest part of the skull behind the clynoid processes. The MIDDLE ARTERY OF THE BRAIN having risen from the side of the sella turcica, runs straight along this fossa Sylvii, and is really the continued trunk of the carotid; it is larger than the artery at the wrist; it goes directly outwards, viz. towards the temple; it runs along the fossa Sylvii, and is lodged deep in that cleft; where it lies deep, it divides into two great branches, one deep and one superficial: it gives some branches to the anterior lobe, but it is chiefly limited to the middle lobe of the brain; its branches to the posterior lobe, or inosculations with any branches of the basilar artery, are comparatively few.

Thus the artery ends by passing into the substance of the brain. But nearer the sella turcica, and before it enters into the fossa Sylvii, it gives some small and delicate arteries; the consideration of which seems to be unimportant at first view, but which is really useful in explaining the anatomy of the brain. It gives small twigs to the pituitary gland, to the optic nerve, to the tentorium, and especially to the pia mater covering the basis of the brain. Among these small twigs certain sets of arteries make a very distinguished figure.

1. There is one small artery which runs up into the anterior horn of the lateral ventricle, and forms that great plexus which lies along the floor of the ventricle,

named PLEXUS CHOROIDES. This, then, is the ARTERY of the CHOROID PLEXUS.

2. There is a set of arteries, of considerable number, but varying in respect of number, small as sewing threads, which inosculate repeatedly with each other, and which are scattered widely and beautifully over the crura cerebri and basis of the brain, forming in the pia mater a plexus or web of vessels. This part of the pia mater is named velum from its beauty and delicacy; and this is what Wepfer, among other older authors, considered as a species at least of the rete mirabile: but that name implies a peculiar office, as in beasts, which this delicate net-work of vessels cannot have.

### 2. ARTERIA ANTERIOR CEREBRI.

The FORE ARTERY of the BRAIN comes off from the middle artery at right angles nearly; for the great or middle artery runs directly outwards towards the temple, while this second artery runs directly forwards along the fore lobe of the brain. It is named sometimes the artery of the corpus callosum, because of two great branches into which it is divided one goes to that part of the brain. The corpus callosum (a most absurd name for any part of the brain) is the white and medullary substance where the two hemispheres of the brain are joined; and upon separating the two hemispheres with the fingers, the corpus callosum is seen like a large white arch, and the artery of the corpus callosum is seen also arching over its surface.

The anatomy of the arteria anterior cerebri may therefore be explained thus: first, it goes off at right angles from the middle artery of the brain, which is to be considered as the trunk, and there it often gives small twigs to the olfactory and optic nerves; next, the two anterior arteries of each side, while they go forwards as if towards the crista galli, bend a little towards each other; they almost meet, but do not

absolutely touch; they form a communication with each other, which of course is exceedingly short, but pretty large. It is this short communication which completes the circle of Willis at its fore part. This cross communication betwixt the arteries of the opposite sides passes just before the sella turcica and pituitary gland, and exactly in the middle it sends off an artery, which goes down into the third ventricle, and gives branches to the fore part of the fornix and to the septum lucidum.

After this communication, both arteries rise, with a large sweep along the flat surface of that deep division which the falx makes betwixt the two hemispheres of the brain: there each divides into its two great branches; one attaches itself to the corpus callosum, or that arch which we see upon holding apart the two hemispheres; it arches along with the corpus callosum so as to describe a semicircle; it is the larger of the two branches; it is named ARTERIA CORPORIS CALLOSI: the other branch keeps upon the flat surface of the brain, where the one hemisphere lies flat upon the other, and it rises in a beautiful arch within the pia mater, dividing into beautiful and very minute ramifications before it enters actually into the substance of the brain.

These two great branches of the anterior artery are well distinguished by Wepfer by the names of arteria profunda and arteria sublimis, (the deep and superficial of the anterior artery,) as there is a deep and a superficial branch of the middle artery. The arch of the arteria anterior cerebri overhangs in a manner that of the artery of the corpus callosum, and both of them inosculate under the falx with the arteries of the opposite side.

### 3. ARTERIA COMMUNICANS.

The COMMUNICATING ARTERY goes as directly backwards from the middle artery as the anterior artery goes forwards. It is small, proceeds backwards, and

a little inwards; it goes round the sides of the corpora mamillaria, and is about a quarter of an inch in length before it meets the branch of the vertebral artery; and though it does give off small twigs, as to the infundibulum, to the optic nerve, to the crura cerebri, and especially one of greater size, to the choroid plexus; yet all these are trivial arteries, such as every trunk at the basis of the brain gives off. It is not its twigs that are to be observed, but itself only that is important, as forming one of the largest and most important inosculations of the body. It unites the middle artery of the brain, which is the trunk of the carotid, with the posterior artery of the brain, which is the first and greatest branch of the vertebral artery.

This anastomosis is the circle of Willis, too remarkable not to have been very long observed; it was drawn by Veslingius and by Casserius; it is but ill represented by Bidloo and by Cowper; it is not a circle, but is right lined, and of course angular: it is of very unequal size; in one body it is large, in another smaller, often even in the same body it is irregular, the one side being large and the other small.

This inosculation brings us round to the first branch of the vertebral arteries, viz. the ARTERIA POSTERIOR CEREBRI; for the vertebral artery gives two arteries to the cerebellum, and one to the back part of the brain.

## OF THE VERTEBRAL ARTERY.

The vertebral artery, though but the secondary artery of the head, is a principal one of the brain, and conveys a very great proportion of blood; and its turnings and windings before it enters the skull are almost as particular as those of the carotid itself. The vertebral is among the first branches of the subclavian artery, and comes off from it where it lies across the root of the neck. The two lower ganglions of the sympathetic nerve lie over it, and their

threads surround its trunk, making curious net-works round it. The artery then enters into the canal prepared for it in the transverse processes of the vertebra, commonly getting in by the 6th vertebra: but in this it is irregular, sometimes entering into the 7th or lowest; and it has been seen entering into the uppermost hole but one. In this canal it ascends in a direct line from the bottom of the neck to the top; but, like the carotid, it makes great contortions before it enters the skull; for when it has reached the second vertebra, its transverse process being rather longer than those of the lower vertebræ, the artery is forced to incline outwards; and the transverse process of the atlas or first vertebra being still much longer, the artery in passing through it is carried still farther outwards; it is forced to make a very sudden turn, and is visible without cutting the bones. When the artery has passed through the transverse process of the atlas, it makes another very sudden turn, lies flat upon the circle of that vertebra, so as to make a large hollowness or groove upon the bone, and then it enters the foramen magnum by rising in a perpendicular direction; and then again it bends and inclines forwards, lying flat along the cuneiform process of the occipital bone, where it soon meets its fellow, and the two uniting form the basilar artery.

This basilar artery lies, with regard to the bone, upon the cuneiform process of the os occipitis, and runs along it from the foramen magnum to the sella turcica; with regard to the brain, it lies upon that great tubercle which is named the tuber annulare or pons Varolii; and as the artery goes along in one great trunk, it gives out from each side little arteries, which belong to this tuber annulare.

The brain has three arteries derived from the vertebral artery as it has from the internal carotid; two are given to the cerebellum and one to the cerebrum.

### 1. ARTERIA CEREBELLI POSTERIOR.

The POSTERIOR ARTERY, or LOWER ARTERY of the CEREBELLUM, is small and not regular. It comes off from the basilar artery either immediately after the union of the vertebrals, or from the vertebral artery immediately before the union. It is often smaller on one side than on the other, and sometimes it is wanting on one side. It moves downwards in a sort of retrograde course betwixt the accessory nerve of Willis and the group of fibres which form the eighth pair, and dives in betwixt the cerebellum and the medulla oblongata. Its larger branches spread out upon the pia mater, and then enter into the medullary substance. They belong to the cerebellum, to the spinal marrow, and some of them to the pons Varolii. But there are also smaller and particular twigs, as twigs to the eighth and ninth pair of nerves: one also which enters into the fourth ventricle, to form a sort of velum or choroid plexus there; and as this posterior artery winds downwards under the cerebellum, it gives many branches about the vermis, and small twigs which run betwixt the lower point of the pons Varolii and the pyramidal bodies.

Next, the ARTERIA BASILARIS proceeds forwards along the pons Varolii in one great trunk: now the pons Varolii is just the tuberosity produced by the crura cerebri and cerebelli, meeting and uniting to form the spinal marrow. The corpora olivaria and pyramidalia are just two bulgings at the root of the spinal marrow; and as every great artery, whatever its destination may be, gives twigs to those parts which it passes over, so does the basilar artery; giving twigs first to the corpora olivaria and pyramidalia, next to the crura cerebelli and to the crura cerebri; and as it runs along the pons Varolii it distributes little arteries to it from right to left. These little arteries also mark the sides of the pons with

small furrows, which are seen when the arteries are dissected away. One of these transverse arteries, longer than the rest, looks like another posterior cerebri. It goes to the seventh pair, or auditory nerve, in the following way: The seventh pair of nerves proceeds from the back part of the pons Varolii; and as it goes forwards, the two nerves which it consists of, viz. the portio dura and the portio mollis, are separated from each other by a small and very beautiful artery which shoots in betwixt them, and enters along with them into the ear. The basilar artery also gives twigs to the fifth and sixth pair of nerves, which arise from the fore part of the pons, as the seventh pair arises from behind.

Arrived at the fore part of the pons Varolii, the basilar artery gives off almost at one point four great arteries, two to the right hand and two to the left. These are the anterior cerebelli and the posterior cerebri.

### 2. ANTERIOR CEREBELLI.

The ANTERIOR ARTERY of the CEREBELLUM, or the upper artery, as it is called, goes off at right angles from the basilar artery, and bends round the crura cerebri to get to the cerebellum. It gives its branches first to the crura cerebelli, to the cerebellum, and to the processus vermiformis. Secondly, There is a greater artery going over all the upper part of the cerebellum, (where it lies under the brain,) and also another which keeps closer to the brain than to the cerebellum, branches over that velum or delicate part of the pia mater which is interposed betwixt the cerebellum and brain; and going along it supplies the crura cerebri, and arrives at last at the place of the nates, testes, and pineal gland, and attaches itself to them. Some of the twigs go down into the fourth ventricle.

### 3. ARTERIA POSTERIOR CEREBRI.

The POSTERIOR ARTERY of the brain goes off immediately after this, is like it, runs parallel with it, is larger, goes to the posterior lobe of the brain, and receives near its root the communicating artery from the carotid, which forms the circle of Willis. Where this posterior cerebri and the anterior cerebelli run parallel with each other, the third pair of nerves rises betwixt them. The posterior cerebri first gives a small twig on either side to the bottom of the third ventricle, which runs so far forwards as to give branches to the thalami, infundibulum, and to the crura fornicis. Then the main artery, bending like that last described round the crura cerebri, and passing deep into the great division betwixt the cerebellum and brain, arches upwards towards the back lobes of the brain; but before it arrives there, it gives first small twigs to the crura cerebri, and then another notable artery (though small) destined for the internal surfaces of the ventricles. This is a chief artery of the choroid plexus; it enters the lateral ventricle by the inferior horn; goes along with the cornu ammonis; helps to form the choroid plexus; inosculates, of course, with the choroid arteries from the carotid; and twigs also go from this artery to the nates, testes, and pineal gland, or in other words, to the velum which separates the cerebellum from the brain, which closes the ventricle behind, and which covers the pineal gland, and is a membrane or velum to it also; the pineal gland, nates, and testes, being situated neither in any of the ventricles, nor on the surface of the brain, but betwixt the surfaces of the cerebrum and cerebellum, where the one lies upon the other.

After this second branch to the internal surfaces, the great trunk of the posterior cerebri branches profusely like a tree all over the back part of the brain, inosculating forwards with the middle artery of the brain, and also with the artery of the corpus callosum.

Thus is the whole brain supplied with blood; and next in order come the arteries of the spinal marrow.

## PLAN, OR RECAPITULATION OF THE ARTERIES OF THE BRAIN.

**INTERNAL CAROTID. CEREBRAL ARTERY.**

1. *Rami Pterygoidei.*
2. *Rami to the Origin of Nerves and the Cavernous Sinus.*
3. ARTERIA OPHTHALMICA..........
   1. *Arteria Centralis Retinæ.*
   2. *Arteria Lacrymalis.*
   3. *Arteria Supra-orbitalis.*
   4. *Arteriæ Ciliares.*
   5. *Arteria Æthmoidalis.*
   6. *Arteria Nasalis.*
   7. *Arteria Frontalis.*
   8. *Arteria Anastomoica.*
4. *Rami to the Pituitary Gland, Nerves, Infundibulum, and membranes.*
5. ARTERIA CEREBRALIS ANTERIOR.
6. ARTERIA CEREBRALIS MEDIA.

VERTEBRAL ARTERY.

1. *Rami Musculares, before entering the Canal.*
2. *Rami Spinales.*
3. *Rami Musculares, under the Occiput.*
4. *Meningeæ Posteriores.*
5. ARTERIA INFERIOR CEREBELLI.
6. *Rami Spinales.*
7. *Union to form the* ARTERIA BASILARIS.
    1. ARTERIA ANTERIOR CEREBELLI.
    2. ARTERIA CEREBRALIS POSTERIOR.
    3. ARTERIA COMMUNICANS.

## OF THE ARTERIES OF THE SPINAL MARROW.

I have mentioned none of those smaller arteries which the vertebral gives off before entering the skull, because, being destined chiefly for the spinal marrow, they belong to this second class.

The vertebral artery, as it mounts along its canal towards the head, gives at each step, or as it passes each vertebra, a delicate twig; these little arteries pass through the intervertebral spaces, go to the deeper muscles of the neck, and inosculate with the thyroid and cervical arteries. In like manner, other small arteries go inwards to the spinal marrow at the place where each nerve comes out. They enter into the sheath of the spinal marrow, and inosculate with the chief arteries of the medulla spinalis.

As the vertebral passes through the atlas, both above and below that bone it gives out much larger arteries to the muscles, as to the recti, trachelo-mastoideus, and complexus, inosculating largely with the occipital artery: often there is at this point one large and particular artery going out to the back of the neck.

Again, as the vertebral passes through the occipital hole, it gives out a little artery, which accompanies the trunk itself up through the foramen magnum, and goes to that part of the dura mater which covers the cuneiform process, and there it inosculates with the twig of the carotid, which enters along with the jugular vein. This is the posterior artery of the dura mater.

Next come the arteries of the spinal marrow, the anterior of which comes out from the trunk of the vertebral artery; the posterior (though it also sometimes comes off from the vertebral before the basilar is formed) more commonly comes off from the posterior cerebelli.

### 1. ARTERIA ANTERIOR MEDULLÆ SPINALIS.

The ANTERIOR ARTERY of the spinal marrow is the larger of the two. It was discovered first by Willis; it had been looked upon, till the time of Veussens, as a nerve accompanying the spinal marrow; because, when empty of blood and uninjected, it is white, and not unlike a nerve. This spinal artery begins within

the skull by two branches, which unite as they proceed down the spine. These two branches arise one from each vertebral artery,. at the very point where the vertebrals are about to unite to form the basilar trunk: each artery passes down its own side of the spinal marrow, betwixt the corpora olivaria and the corpora pyramidalia; each artery, before it leaves the skull, gives twigs to the tuber annulare, and to the pyramidal and oval bodies, for they are the beginnings of the spinal marrow; and soon after emerging from the skull *, the two spinal arteries join so as to form one anterior spinal artery. This joining is usually at the top of the neck, or rather within the skull, but sometimes so low as the last vertebra of the back. Almost always they join within the head or near it; and the anterior spinal artery which they form descends along the spinal marrow in a furrow which it forms for itself. The peculiar office of this artery is to supply the spinal marrow and its sheath, which it does by sending continual branches into the substance of the spinal marrow; while other branches go into the sheath itself, and pass out from the spinal canal along with those nerves which go out from the spinal marrow, accompanied by little processes of the sheath, which are named processus denticulati.

But this artery, being extremely small, would be soon exhausted, were it not reinforced with small arteries coming into the sheath: these pass through the vertebral interstices into the spinal canal, and are derived from every artery that passes near the spine. Thus in the neck, the spinal artery receives twigs from the vertebral arteries, and from the thyroid and cervical arteries; in the back it receives twigs very regularly from each of the intercostal arteries, and it receives its twigs from the lumbar arteries when it has got down as low as the loins.

But this spinal artery, which is continually diminishing, at last fails in the loins; and where the cauda

* The artery which accompanies the ninth pair or lingual nerve, often comes from the anterior spinal artery.

equina is, that is, principally in the canal of the os sacrum, the medulla is no longer supplied by a spinal artery, but by the small branches of the sacral arteries, which enter by the ten holes of the sacrum.

Of those adventitious branches which reinforce the artery of the spinal marrow as it descends through the spine, each gives several other branches; they give twigs to the muscles of the spine, twigs to the substance of the vertebræ themselves, twigs to the sheath of the spinal marrow; and, finally, twigs which inosculate with the spinal artery, and which sink into the nervous substance to nourish it.

### 2. ARTERIA SPINALIS POSTERIOR.

The POSTERIOR SPINAL ARTERY differs in all essential points from the anterior: first, there are two posterior spinal arteries which arise, not from the basilar or vertebral arteries like the anterior, but usually from the arteria anterior cerebri; and they are smaller than the anterior spinal artery. Secondly, these two arteries give small twigs to the bottom of the fourth ventricle, and then go round from the fore to the back part of the medulla oblongata; but there, instead of uniting like the beginnings of the anterior artery, they continue separate, run down the spinal marrow as two distinct arteries, with very frequent inosculations betwixt them. This artery is also unlike the other in respect of its termination, for it disappears at the second vertebra of the loins. Its inosculations with the arteries from without are very free.

## OF THE ARTERIES OF THE EYE.

The arteries of the eye, as we have seen in the plan, come from one branch only, the ophthalmic artery, the branch which the carotid, when it touches

the anterior clynoid process, sends into the orbit along with the optic nerve. But small as this original artery is, (not so big as a crow-quill,) the system of arteries which arises from it is very great; whether we consider their number, the irregular parts which they supply, or the great inosculations which they form even with the outward arteries of the nose and face.

These are reasons for setting this order of arteries apart; and even with all possible care in the arrangement, it is not easy to deliver an orderly intelligible history of this artery. The ophthalmic artery supplies not only the eye itself, *i. e.* the globe, but it supplies also all the apparatus, if I may so call it, of the eye, *i. e.* the muscles, the lachrymal gland, the eye-lids, and even the forehead and nose.

1st, It sends a great branch, which leaves the ophthalmic artery, and takes its course outwards and upwards along the eye, to supply the lachrymal gland where it is exhausted. 2dly, The ophthalmic supplies the eye itself, both by that artery which enters into the centre of the optic nerve, called arteria centralis retinæ, and also by other arteries which are named the ciliary arteries; because they go onwards to the fore part of the eye, where the ciliary circle is. 3dly, The muscles are supplied by an artery which comes from the same place nearly with those ciliary arteries. 4thly, There are two arteries which go down through holes in the socket into the bones and cavities of the nose; and these, as they perforate chiefly the æthmoid bone, are named æthmoid arteries. 5thly, and lastly, Those arteries which go out upon the forehead and nose are so directly from the trunk of the ophthalmic artery, that they must be regarded as the termination of it. This is the system of vessels which comes now to be described, and this is, perhaps, the best order for the description.

## ARTERIA LACHRYMALIS.

The LACHRYMAL ARTERY is the first branch of the ophthalmic; but in order to know its place correctly, we must first observe how the ophthalmic artery enters the orbit. It comes off from the carotid, where that artery touches the clynoid process; and is so close upon the process, that the setting off of the ophthalmic is almost covered by that projection. It then dives under the optic nerve, and appears on the outer side of it; and as the artery goes along through the orbit, it makes a spiral turn till it completely surrounds the nerve.

The lachrymal artery goes off from the ophthalmic immediately after entering the orbit *, though sometimes it arises from the artery of the dura mater; and then it enters by the foramen lacerum, which is the next opening to the optic hole. It goes off from the ophthalmic about two or three lines after it has entered the socket. It goes all along the outer side of the orbit, because the lachrymal gland lies in the outer corner of the eye. When it reaches the gland, it is branched out and entirely expended upon it, except that it sends some small twigs forwards to the eye-lid. Of these vagrant branches, one twig goes to the periosteum of the orbit, perforates the cheek-bone, and so gets into the hollow of the temple, inosculating with the deep temporal artery; while another little branch goes to the tarsus of the upper eye-lid, and another to the tarsus of the lower eye-lid, and thus ends the lachrymal artery.

## ARTERIA CENTRALIS RETINÆ.

This branch of the ophthalmic artery is so named because it perforates the optic nerve, runs up through its very centre or axis, enters into the cavity of the

* Sometimes it goes off one or two lines before the ophthalmic enters the optic hole, sometimes from the middle of the artery.

eye through the very centre of the optic nerve, and spreads its branches all over the retina. It usually arises from the ophthalmic artery, where it turns in the middle of the orbit over the upper part of the optic nerve *; it plunges into the nerve; and this artery, or rather the artery and vein, both (for the vein accompanies it) make so large a canal in the centre of the optic nerve, that their sheath stands quite open and gaping when the nerve is cut across; and was long known to the older anatomists by the name of porus opticus, before the meaning of this orifice or hole was understood.

When this artery arrives within the eye it branches out most beautifully upon the outer delicate membrane of the retina. The angles and meshes which this artery makes give the name of retina or net-like to the whole; for the pulpy part of the optic nerve expands into a very thin and delicate web which resembles mucus. This web has its strength from these branches of the central artery. The branches of the artery, and the mucus-like expansion of the nerve, lie in two separate layers; and hence some anatomists reckon the retina a double membrane.

The arteria centralis having given off sideways these innumerable branches to the retina, still goes forwards, plunges through the substance of the vitreous humour, does not stop till it arrives at the back part of the lens, and is of course the ARTERIA CENTRALIS OCULI, the central artery of the eye itself. This central artery cannot be seen in the adult, and therefore there may be a question as to their existence at all; but by injecting the arteries of the eye of a fœtus, of a slink Calf, or of any young animal, the arteria centralis oculi is found to distribute its branches in the following way: As it goes forwards through the centre of the eye-ball, it gives off its delicate arteries from side to side, which go along the partitions of the vitreous humour (for the

* It may be found arising from the ciliary arteries, or sometimes from the muscular.

vitreous humour is divided every where by membranes into small honey-comb-like cells). These cross arteries inosculate with those of the retina, and are plainly the arteries which secrete and support the vitreous humour. * The central artery stops when it comes to the back of the lens: it is scattered in a radiated form, as if by the resistance, into many great branches. These branches go round all the capsule of the lens, and meet again on its fore part; where, uniting into one or more small arteries, they pass onwards into the opening of the pupil, and help to form that membrane which in the fœtus passes from the margin of the iris, and shuts the pupil.

So the arteria centralis retinæ passes first through the centre of the optic nerve; next through the centre of the vitreous humour; next, after going round the capsule of the lens, it passes through the posterior chamber of the aqueous humour, and terminates in the centre of the pupil. But as these last arteries, viz. of the pupil, vanish soon after birth, we may consider the central artery as ending in inosculations with those arteries, which coming upwards along the sides of the eye along with the retina, form a strong circle of arteries at the root of the ciliary process.

## ARTERIÆ CILIARES.

The ciliary circle is known, upon looking outwardly at the eye, by that white line which borders the iris, and separates the iris or coloured part of the eye from the white or colourless part. That circle marks the place where there is a great concourse of arteries. The corpus ciliare, or ciliary body, is the part within the eye which lies flat upon the fore part of the vitreous and crystalline humours,

* I have observed the artery branching in the midst of the vitreous humour, but these branches I have seen terminating on the back of the capsule of the lens.—C. B.

which is like a second iris behind the first, which is extremely vascular, and corresponds with the ciliary circle without. This corpus ciliare is radiated (that is a consequence of the peculiar order and arrangement of its vessels, which run in rays from the ciliary circle, *i.e.* from the circumference towards the centre). These radii coming from the ciliary circle are called the ciliary processes; so that the ciliary circle, corpus ciliare, and ciliary processes, are all parts of the same vascular organ. This is the part of the eye to which all those arteries go which are next to be described.

1. Two arteries of considerable size go off from the sides of the ophthalmic artery: these go along the sides of the optic nerve; they go towards the ball of the eye; and the one on the outer side of the eye is named EXTERNAL CILIARY ARTERY, that on the inner side of the optic nerve is named the INTERNAL CILIARY.

2. These two divide themselves again into two subordinate branches: one of them as soon as it touches the eye, that is, just beyond the implantation of the optic nerve, enters its substance, and is spread out on its choroid coat in a great number of branches, which are named CILIARES BREVES, the short ciliary arteries: the other goes further forward upon the eye before it enters, and even after it enters, it still goes forwards to the very fore part of the eye before it divides; hence named CILIARES LONGÆ.

3. The ANTERIOR CILIARY ARTERIES are some small and uncertain branches, which come sometimes from one source, sometimes from another, but most commonly from the muscular branches; and they go along with the muscles, and consequently enter the eye at its fore part just where the recti muscles are inserted. But, though small, these anterior ciliary arteries are of considerable number.

From the places at which these several arteries enter the ball, one might guess à priori how they will be distributed through its coats.

The ciliary arteries do not all of them arise from the ophthalmic artery; many arise from the muscular branches. As soon as they touch the eye-ball, they enter into it near the insertion of the optic nerve, pass through the sclerotic coat (leaving for its nourishment a few twigs); they divide so, that just after they have entered, we can count twenty-five or thirty all round the root of the optic nerve which go forwards in a radiated form, and are completely diffused upon the choroid coat; these are the POSTERIOR CILIARY ARTERIES. This coat of vessels lines the choroid all the way forward to the lens, goes still onwards to the fore part of the lens; and then turning down upon the lens at right angles, it meets with the anterior vessels, and forms the ciliary circle, and the ciliary processes or radii; a few twigs go still forward upon the uvea and iris, so as to make a very important connection of all the vascular parts of the eye.

Secondly, The LONGER CILIARY ARTERIES enter the sclerotic a little further forward, and penetrate at a greater distance from the optic nerve. They are two arteries thus distinguished; they pass forward betwixt the sclerotic and choroid coats, and on approaching the ciliary circle, they each divide and make a circle of inosculation. Their branches meet each other, and are now joined both by the shorter ciliary arteries and by the anterior ciliary arteries; by which conjunction an anterior circle is formed, which corresponds with the outer circle of the uvea, and is called the OUTER CILIARY CIRCLE: this again sends radii of vessels, perhaps 30, inwards, which meeting, form a second circle, the INNER CILIARY CIRCLE.

Thirdly, The anterior ciliary arteries enter the eye at its fore part, and immediately unite with these, as has just been explained; they help to form the ciliary circle, which is the great conjunction of all the internal vessels of the eye.

The MUSCULAR ARTERIES are the least regular of all the branches of the ophthalmic artery. From one or other branch of the ophthalmic there generally arise two muscular arteries; the one for the upper, the other for the lower muscles.

### ARTERIA MUSCULARIS SUPERIOR.

The UPPER MUSCULAR ARTERY consists of small twigs, which go chiefly to the levator palpebræ and rectus superior; and these, though they sometimes arise as two small twigs from the ophthalmic artery itself, yet in general come off rather from that artery which, as it goes out by the supra-orbitary hole, is named the supra-orbitary artery. These muscular branches of the supra-orbitary, then, supply the upper muscles of the eye, as the levator palpebræ, the obliquus major, the rectus superior, and the sclerotic or outer coat of the eye.

### ARTERIA MUSCULARIS INFERIOR.

The LOWER MUSCULAR ARTERY is very generally an independent artery, and pretty large. It comes off from that part of the ophthalmic artery where it is giving off the ciliary arteries. This muscular branch is large enough to give off sometimes the arteria centralis retinæ, and often some of the short ciliary arteries arise from it; it is so long as even to reach the lower eye-lid. The muscles which it supplies are all those which lie on the lower part of the eye, as the deprimens oculi, abducens oculi, obliquus minor. It also gives variable twigs to the sclerotica, the optic nerve, the periosteum of the orbit, and sometimes to the adnata and lower eye-lid.

The set of arteries which stand next in order are those which go down into the nose through the æthmoidal bone, whence they are named æthmoidal arteries. The æthmoidal arteries are, like the other branches of the ophthalmic, pretty regular in their

destination, but far from being regular in the manner in which they arise.

### ARTERIA ÆTHMOIDALIS POSTERIOR.

The POSTERIOR ÆTHMOIDAL ARTERY is so named, because it passes through the posterior of two holes which are in the orbit at the joining of the æthmoidal with the frontal bone.* It is an artery by no means regular in its place, coming sometimes from the ophthalmic trunk, sometimes from the lachrymal artery, very rarely from the supra-orbitary artery. It is of no note: it is the smaller of the two æthmoidal arteries; it goes through its hole, and is scattered upon the bones and membranes of the nose. While it is circulating its twigs among the æthmoidal cells, it inosculates, of course, with the nasal arteries of the external carotid.

### ARTERIA ÆTHMOIDALIS ANTERIOR.

The anterior æthmoidal artery is rather more regular and more important; it passes through a larger hole, and is itself larger; it comes off more regularly from the ophthalmic trunk, and it goes not down into the nose, but upwards into the skull.

The ophthalmic artery, much exhausted by giving off many branches, has risen over the optic nerve, has completed its spiral turn, and has just got to the inner corner of the eye, where the æthmoid hole is when the anterior æthmoid artery arises from it. It arises just behind the pulley of the upper oblique muscle, plunges immediately into its peculiar hole, and, passing along a canal within the æthmoid bone, it merely gives twigs to the frontal and æthmoidal sinuses, and passes up by one of the largest holes in the cribriform plate of the æthmoid bone. When within the skull, it is under the dura mater, betwixt

* In describing the skull, these are named the internal orbitary holes.

it and the bone; it goes to the dura mater and to the root of the falx, and some of its delicate twigs turn downwards again into the nose, through the small holes of the cribriform plate accompanying the branches of the olfactory nerve.

The fifth order of arteries is very numerous, including all those which send their twigs outwards upon the face. They are the supra-orbitary artery, the artery of the upper eyelid, the artery of the lower eyelid, the artery of the forehead, and the artery of the nose.

### ARTERIA SUPRA-ORBITALIS.

The supra-orbitary artery is so named from its emerging from the socket by that notch in the superciliary ridge which we call the supra-orbitary hole. It comes off from the ophthalmic artery at the place where it gives off the ciliary and lower muscular arteries: it so often gives off the arteries which go to the upper muscles of the eye, that some have named it the superior muscular artery. It passes onwards, giving twigs to the levators of the eye and of the eyelid, and to the upper oblique muscles, and to the periosteum: and before it arrives at the supra-orbitary hole, it divides into two twigs; of which one lies deep, and supplies the periosteum of the forehead, inosculating with the temporal artery; the other lies more superficial, but still is covered by the orbicularis and corrugator supercilii, on which muscles it bestows all its branches.

### ARTERIÆ PALPEBRALES.

The two PALPEBRAL ARTERIES arise from the ophthalmic after it has passed the tendon of the obliquus superior, when it has in a manner emerged from the socket, and is lying at the inner angle of the eye; there it commonly gives off two small arteries, one

to the upper and one to the lower eye-lid: and often the two arise by one trunk.

ARTERIA PALPEBRALIS INFERIOR.—The ARTERY of the LOWER EYELID is the branch of the two which goes off the first; but it is the smaller and less regular of the two. Its twigs go, one to the union of the two tarsal cartilages, to the caruncula lachrymalis, and to the adjoining part of the adnata; another goes deeper, viz. to the lachrymal sac, and even into the æthmoid cells; and a third twig runs along the margin of the tarsus, named tarsal artery, supplying the Meibomean glands.

ARTERIA PALPEBRALIS SUPERIOR.—The ARTERY of the UPPER EYELID arises along with the lower palpebral, or near it; it gives few branches; one keeps to the angle of the eye, and supplies the orbicularis oculi, the caruncula, and the tunica conjunctiva; another having pierced the fibres of the oblique muscle, runs along the borders of the tarsus, inosculating with a similar branch of the lachrymal artery, and forming an arch along the upper tarsus as the other does below.

## ARTERIA NASALIS.

The NASAL ARTERY goes off at the edge of the orbit, rises over the lachrymal sac, and over the ligament of the eyelids; it first gives a twig upwards to the root of the frontal muscle; then another goes down over the lachrymal sac, and after giving branches to the sac, goes to the orbicularis muscle, and inosculates with the infra-orbitary artery; and lastly, the most remarkable branch of this artery, from which indeed it has its name, runs down upon the side of the nose, making a beautiful net-work, and inosculating with the last branch of the labial artery, called angularis, which runs up to meet it.* This is quite

* Some of its branches absolutely penetrate the cartilages of the nose, and so get access to the Schneiderian membrane, and supply it with blood.

a cutaneous artery; many of its twigs go to the skin; it is felt beating strongly; it was often opened when arteriotomy was more regarded than it is now.

### ARTERIA FRONTALIS.

The FRONTAL ARTERY is now to be distinguished from the supra-orbital; for the supra-orbital rises deep in the socket, emerges by the supra-orbitary hole, passes along chiefly betwixt the bone and muscles, and makes no remarkable figure upon the face; while this frontal artery keeps chiefly upon the surface of the muscles, is quite subcutaneous, has nothing to do with the supra-orbitary hole, and rises beautifully upon the forehead. It is a delicate and slender artery, not so large as the nasal, and looks like one of its branches; it gives off first a branch to the eyelids, named superciliary artery, which supplies the root of the frontal and the upper part of the orbicularis muscles; it sends an ascending branch which dives under the frontal muscle, and belongs chiefly to the os frontis and pericranium. This is the little artery which often makes a perpendicular groove in the os frontis. The chief branch of the artery continues subcutaneous, is felt beating along the forehead, belongs chiefly to the skin of the forehead and to the hairy scalp, and mounts to the top of the head, to the place of the fontanelle, where it has free inosculations with the temporal artery.

This last branch is the end of the ocular or ophthalmic artery, of which the branches are so irregular in their origin, that the most diligent anatomists have declined that part of the description, and yet have arranged the branches upon that scheme, viz. the points from which the several twigs arise: whereas I have thought it more prudent, since the branches are regular in respect of the parts which they supply, to arrange them according to those parts, viz. the lachrymal gland, the eyeball, the muscles, the æthmoid cells, the face; an order which also very nearly corre-

sponds with the order in which the arteries arise. The learning and remembering these arteries, it is right to acknowledge, is a task more difficult than useful; more suiting the severe anatomist, than the practical surgeon; yet who, if he do his duty, will learn all; and as he learns much, must expect to forget much.

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## OF THE ARTERIES OF THE ARM.

The subclavian arteries arise from the arch of the aorta. The left subclavian arises from the extremity of the arch, and just where the aorta is turning down towards the spine. It is longer within the thorax, runs more obliquely to pass out of the chest, receives in a less favourable direction the current of the blood. But the right subclavian arises from the aorta by that artery which is called the ARTERIA INNOMINATA; for it is an artery which can have no name, being neither the carotid nor the subclavian, but a trunk common to both. It is large, rises from the top of the aortic arch, receives the blood in the most direct manner; from which physiologists have deduced those consequences which have been already explained.*

1. The artery of the arm, as it proceeds, changes its name according to the parts through which it passes. It is named subclavian within the breast, axillary in the arm-pit, brachial as it goes down the arm, and when it divides at the bending of the arm its two branches are named the radial and ulnar arteries, after the radius and ulna, along which they run, until at last they join to form vascular arches in the palm of the hand.

Nature has thus arranged and divided the parts of this artery; and the study of its branches becomes

* Douglas says the left is shorter, which I can by no means understand.

easy to those who will first condescend to observe this simple arrangement and the. parts through which it goes. 1st, While the artery is within the breast, it lies transversely across the root of the neck ; it supplies the neck, the breast, the shoulder ; it gives all its branches upwards into the neck, or downwards into the breast : upwards it gives the vertebral to the inside of the neck (if I may use an expression which cannot now be misunderstood) ; the cervical, which goes to the outside of the muscles of the neck ; the thyroid, which goes to the thyroid gland. While it gives off from its opposite side downwards, and into the chest, the mammary, which goes to the inner surface of the breast ; the upper intercostal artery, which serves the space betwixt the uppermost ribs ; the mediastinum and pericardium, and even the diaphragm, though far distant, receive branches from this mammary artery.

2. When the artery, having turned over the sloping part of the chest, glides into the axilla, and lies deep there betwixt the scapula and the thorax, what parts can it supply, or what vessels can it give off, but scapular and thoracic arteries ? Its branches accordingly are three or four slender arteries to the thorax on one hand, named the four thoracic arteries, which give twigs to the glands, the pectoral muscles, and the breast or mamma ; and on the other hand it gives off first great articular arteries which surround the joint, and still great scapular arteries which surround the scapula, and nourish all that great mass of flesh which lies upon it.

3. But when this artery takes the name of the humeral artery, and passes along the arm, it must be simple, as the arm is simple ; for it consists of a bone, of one mass of muscles before, and another behind : the artery of course runs along the bone undivided, except that it gives off one branch, which runs parallel with the main artery, and running deeper among the flesh, is named muscularis or profunda.

4. It divides at the bend of the arm, in order to

pass into the fore arm in three great branches. In wounds thus low, all danger of losing the arm from wounds of the artery, unless by the gross ignorance or fault of the surgeon, is over: we do not attend so much to the parts which it supplies, or, in other words, to its inosculations, as to the parts against which the great branches lie. We observe here, as on all occasions, the artery seeking protection, and running upon the firmest parts: its three branches now pass; one along the radius, another along the ulna, a third along the interosseous membrane.

5. In the palm of the hand we find the artery still following the order of the bones; and as the carpal bones are as a centre or nucleus, upon which the metacarpal and finger bones stand like radii, the palmar artery forms a complete arch, from which all the fingers are supplied by arteries, issuing in a radiated form.

Of all these subdivisions the subclavian artery is that which seems the least important to know; and yet without a perfect knowledge of it, how shall we understand many important arteries of the neck or shoulder? How shall we understand the anatomy of the greatest of all the nerves, viz. the sympathetic nerve which twists round it? How shall we judge rightly of tumours near it, or of aneurisms which so often mount along this artery from the arch of the aorta until they are felt here?——Of the second division of the artery, viz. where it lies in the axilla, the importance is most unequivocal; since every attempt to stop hemorrhages, by compressing this artery, requires a knowledge of it; since every full bleeding wound near this place alarms us, and requires all our knowledge; since every tumour that is to be extirpated opens some of its branches; since we cannot cut off a cancerous breast, or the glands which should be taken along with it, without cutting the thoracic arteries.—Next the artery of the arm, simple as it is, interests us greatly. It is this simple artery which is hurt in aneurisms; it is its delicate, I

had almost said capillary, branches, which are to establish a new circulation, and to save the limb. We have indeed no apprehensions of losing the limb for want of blood (the continual success of our operations having established this point); yet it is most interesting to observe the extreme smallness of these branches, as an assurance to us in other cases of danger; though I do indeed believe, that there cannot in any simple wound in any limb be the smallest danger from this much dreaded obstruction of the blood.

The arteries of the fore arm are more interesting still; for if we will be so selfish as to consider the difficulties of the surgeon merely, wounds of the arteries in the fore arm are very distressing. These arteries lie deep among the muscles, drive their blood (when wounded) through the whole arm, and either occasion a difficult and most painful dissection, or cause a deep and gangrenous suppuration; so that whether the surgeon be so dexterous as to secure the arteries, or so timid as to leave the arm in this woeful condition, the patient is to undergo such sufferings by pain or by a long disease, as must interest us greatly.

The arteries even of the wrist and hand, though small, are important. The difficulty of managing wounds of these arteries stands but too often recorded in all kinds of books for us to doubt the fact. If many have died after frequent bleedings from these arteries, though under skilful hands, what ought we not to submit to in the way of study and labour to acquire and to retain a knowledge of these arteries; since by that alone every thing that is surgical in tumours, aneurisms, amputations, is well or ill performed, according to our degree of knowledge; and since, according to our degree of knowledge, we are disengaged in our minds, and have free possession of our judgment, to do any thing which may be required? In short, as we proceed along this artery, we shall perceive that each division of it rises in im-

portance; or at least that if wounds about the axilla be more dangerous, they are proportionably rare; that if accidents about the wrist or hand be less dangerous, they are, however, more frequent, so as to deserve every degree of attention.

## I. OF THE SUBCLAVIAN ARTERY.

This artery is so named from its passing under the clavicle by which it is protected; and we include under this division all that part of the artery which lies betwixt the arch of the aorta and the outside of the clavicle, where the artery comes out upon the chest. Here the artery is of a very great size; it lies directly across at the top of the chest and root of the neck; and like a cylinder or axis, it gives its branches directly upwards and directly downwards to the throat, to the neck, and the parts within the chest. Upwards it sends the vertebral, the thyroid, the cervical, and all the humeral arteries; downwards it sends the upper intercostal artery, and also the internal mammary, which, besides its going along the inner surfaces of the chest, gives branches to the pericardium, mediastinum, thymus, and other parts.

### 1. ARTERIA MAMMARIA INTERNA.

The INTERNAL MAMMARY ARTERY is the first which the subclavian gives off; it is of the size of a crow-quill, long, slender, its ramifications very beautiful. On each side of the chest the mammary artery passes down along all the inner surface of the sternum, and ends at the cartilago ensiformis, in numerous inosculations with the epigastric artery; for the epigastric arises from the femoral at the groin, just as this does from the subclavian at the top of the chest, and runs upwards along the belly, as the mammary runs downwards along the breast till they meet each other

midway. This is an inosculation which fifty years ago was much noticed. Physiologists deduced the most important consequences from it, ascribing the connection of the breast and womb to the flux and reflux, to the alternate stoppage and acceleration of the blood in these vessels; although the sympathy of the breasts and womb is plainly a connection which Nature has established upon other laws, upon a kind of sympathy such as we see everywhere in the system, but can in no instance explain.

The course of the mammary artery, and the order of its branches, is this: It goes off from the lower and fore part of the subclavian artery; it lies on the outside of the membranous bag of the pleura; and considering the pleura as ending in an obtuse and rising apex, the mammary artery lies at first a little behind the pleura, its first movement is to rise and turn with an arch over the top of the pleura or bag which incloses the cavity of the chest; there it descends again, and passes betwixt the ribs and pleura; the artery runs along the inside of the thorax under the middle of the cartilages. At the seventh or eighth rib the mammary itself emerges from the thorax, and becomes an external artery; it first sends a branch towards the ensiform cartilage, which plays round it, and then it goes to the upper part of the abdominal muscles by two distinct branches, the one of which is internal, the other external. The internal branch goes into the belly or substance of the rectus muscle, descends nearly as far as the navel, and inosculates with the epigastric artery. The external branch turns off to one side, goes rather to the lateral muscles of the abdomen, especially to the two oblique muscles, and inosculates more with the lumbar arteries; and so the mammary ends. But as it passes down along the chest, it gives the following branches:—

First, Where it is passing the clavicle, bending to go downwards, it gives a small retrograde branch

which follows the course of the calvicle, and goes to the muscles and skin of the neck. *

Secondly, It gives an artery, or rather arteries, to the thymus, ARTERIÆ THYMICÆ. These are in the adult extremely small, because the gland itself is so; but in the child the gland is large, the upper part lies before the trachea, the lower part lies upon the heart, or rather upon the pericardium betwixt the two lobes of the lungs: the upper end then is supplied by the thyroid arteries; the middle part is often supplied by a distinct and particular branch, viz. by the ARTERIA THYMICA coming from the mammary, but this is far from being always so; the lowest part of the gland has twigs from those arteries which properly belong to the mediastinum, upon which it lies, or to the pericardium, or to the diaphragm.

Thirdly, The mammary gives also the upper artery of the diaphragm, its lower artery being the first branch of the aorta within the abdomen. This upper artery of the diaphragm is named ARTERIA COMES NERVI PHRENICI, because it accompanies the phrenic nerve. The phrenic nerve is passing from the neck (where it arises) into the chest, by the side of the axillary artery, when it receives from the mammary this small artery which goes along with it; and this artery (which is so extremely small that nothing but its regularity can give it any importance) goes down through the whole chest, accompanying the phrenic nerve over the pericardium till they arrive together on the upper surface of the diaphragm, and spread out there. This artery, small as it is, gives twigs as it passes along to almost all the parts within the chest.

Fourthly, The mammary gives an artery to the pericardium, which may be called the UPPER PERI-

* Sabbatier is so confused, and copies Haller so ill, that he mistakes this for the transversalis humeri, which is really an important artery.

CARDIAC ARTERY; and which is of such importance, that generally when it does not come off from the mammary, it comes from the subclavian itself, or even from the aorta. It belongs to the upper and back part of the pericardium.

Fifthly, The pericardium has another artery from the mammary, which belongs to that part of it which is united to the diaphragm: it is thence named by some ARTERIA PHRENICO-PERICARDIACA.

Sixthly, The mammary gives many small arteries to the mediastinum; for the mammary is covered only by the sterno-costalis muscle, which is often hardly visible in Man, so that the artery may be said to lie upon the pleura, betwixt it and the ribs. The mediastinum is just that doubling of the pleuræ which descends from the sternum to the spine, and of course many small arteries go down from the lower surface of the sternum along the pleuræ into the mediastinum, and by that to the pericardium, or even to the membrane of the lungs.

The mammary, as it goes downwards, sends branches through the interstices of the ribs; two twigs pass through each interstice, going to the intercostal muscles, and to the muscles which lie upon the thorax, as the pectoral muscles; also to the mamma, to the obliquus externus abdominis: they form loops of inosculations round the ribs with the proper intercostal and thoracic arteries. These twigs pass through the interstices of the six or seven upper ribs, but at the seventh the artery itself comes out. They are too numerous and too small to be either counted or named.

Seventh, The mammary, before it terminates in the two branches, of which one keeps the middle and goes to the rectus muscle, while the other goes outwards to the oblique muscle, as already described, gives about the place of the sixth rib a branch, which in place of passing out of the thorax, keeps to its inner surface, goes downwards along the seventh, eighth, and ninth ribs, makes its inosculations there

with the intercostal and other arteries, and ends in the side of the diaphragm, and in the transverse or innermost muscle of the abdomen, which indigitates, as we call it, with the diaphragm. From this destination it is sometimes named the RAMUS MUSCULO-PHRENICUS.

PLAN, OR RECAPITULATION OF THE BRANCHES OF THE

MAMMARIA INTERNA.
1. *Rami Mammariæ intercostales.*
2. *Arteria Thymica.*
3. *Arteria Comes Nervi Phrenici.*
4. *Arteria Pericardiaca.*
5. *Arteria Mediastinæ.*
6. *Arteriæ Diaphragmaticæ.*
7. *Arteria Epigastrica Communicans.*

### 2. ARTERIA THYROIDEA INFERIOR.

The LOWER THYROID ARTERY, whose branches go to the neck, the shoulder, and the thyroid gland, arises from the fore part of the subclavian artery, close upon the origin of the internal mammary. It is there covered by the root of the mastoid muscle. It buds out from the root of the great axillary artery, in the form of a short thick stump, which immediately divides whip-like into four small and slender arteries.

1. The main branch of this artery is again named the *ramus thyroideus arteriæ thyroideæ*. This thyroid artery is the first great branch; it does not ascend directly, but moves a little inwards towards the trachea, from which the root is a good deal removed; it bends behind the carotid artery, is tortuous, ascends by the side of the trachea till it touches the lower lobe of the thyroid gland; it spreads upon it like a hand, inosculates very freely with the upper thyroid artery, and nourishes the gland. This branch moreover gives some twigs upwards to the lower constrictors of the pharnyx and to the œsophagus; but its chief arteries, beside those which plunge into the gland, are its TRACHEAL ARTERIES. These tracheal arteries, two or three in number,

are reflected along the trachea, turn down with it into the chest, and reach even to the bifurcation of the trachea, where, inosculating with the intercostal arteries, they form a most beautiful net-work.

2. The ascending thyroid artery, or *thyroidea ascendens*, is a small and delicate branch, which lies pretty deep, going off rather from the back part of the artery; it supplies all the deep parts of the neck, and even penetrates the vertebræ; it soon divides into an irregular number of branches; the artery keeps almost close to the naked vertebræ, lying under most of the muscles; its general tendency is upwards, surrounding the neck in a spiral form. Its chief twigs are, first, some which go towards the surface, *i. e.* to the muscles which lie over the artery, as to the scalenus, the mastoid muscle, the levator scapulæ, and the splenius: and twigs of this artery play over the rectus capitis and the anterior surface of the vertebræ, and attach themselves to the eighth pair of nerves, and to the ganglion of the sympathetic nerve. Its deeper arteries again go to the inner-transversarii, and other muscles which lie closer upon the neck; and these are the branches which pass in through the intervertebral holes, and penetrating the sheath of the spinal marrow, and following its nerves, inosculate with the spinal arteries.

3. The transverse artery of the neck, or transversalis colli, is an artery of the same kind with the last, viz. chiefly destined for the muscles, but more superficial. It passes obliquely round the neck outwards and upwards, goes under the trapezius muscle, and covered by it sends branches as far as the occiput. Its twigs are distributed thus: First, to the mastoid muscle and to the skin; next, to the trapezius, levator scapulæ, and splenius; then, a long branch passing obliquely upwards over the splenius, and under cover of the trapezius, gives twigs to those muscles, and ends in inosculations with the lower branches of the occipital artery; and, lastly, another branch goes downwards towards the scapula and shoulder.

4. The last branch of this artery is the TRANSVERSALIS HUMERI; an artery so important in its destination, and so irregular in its origin, and so frequently arising as a distinct and particular branch, and having so little relation to these trivial branches of the thyroid artery, that I shall describe it by itself.

### 3. ARTERIA VERTEBRALIS.

The vertebral artery arises next from the upper part of the subclavian artery; and running upwards and backwards but a little way, it plunges into the hole destined for it in the vertebræ; and it has been already described through all its course both within the bony canal and within the brain.

### 4. ARTERIA CERVICALIS PROFUNDA.

The deep cervical artery comes next in order; it is generally the least important of all the branches from the subclavian artery, and the least regular in its place. It often comes from some other branch, and often it is entirely wanting; its course resembles a good deal that of the transversalis colli, *i. e.* it goes to the deepest muscles of the neck, and to the vertebræ, and ends about the occiput; it usually arises from that part of the subclavian artery where it is just going to pass, or has already passed, betwixt the scaleni muscles. Its branches are few in number, it gives branches to all the scaleni muscles; others also which play over the anterior surface of the vertebræ and the deep muscles of the neck, as the spinalis colli, inter-transversarii, the root of the splenius and trachelo-mastoideus; the complexus also receives a branch, which usually inosculates with the occipital artery.

### 5. ARTERIA CERVICALIS SUPERFICIALIS.

The SUPERFICIAL CERVICAL ARTERY is still less regular, being very often supplied by the thyroid. Its course is directly the reverse of the last, running rather outwards and downwards, or in other words, belonging rather to the shoulder than to the neck. The subclavian artery has got from under the muscles, and has passed the splenii a little way before it gives off this superficial cervical. This artery immediately attaches itself to the plexus of the brachial nerve, and is indeed hidden in the plexus: its first branch is given to the plexus, but its next and chief branch goes across to the top of the shoulder; it sends branches to the levator scapulæ, trapezius, and even to the skin; while a deeper branch goes to the splenius and complexus, where these muscles arise in the neck; and when this artery is large, it sends branches along the margin of the scapula, which go even to the seratus major, rhomboidei, latissimus dorsi, &c.

After enumerating these jarring names, I perceive the necessity of arranging once more those arteries which go to the neck. Let the student then observe, 1. That the vertebral artery goes to the brain, that the cervical arteries belong to the muscles of the neck. 2. That the thyroid gives two arteries to the neck, the thyroidea ascendens and the transversalis colli. 3. That when a second set of arteries for the neck begins to be enumerated, the name is changed; that of colli is dropped, and that of cervicis adopted. 4. That as there are two branches of the thyroid going to the neck, viz. the ascending thyroid and the transversalis colli, there are also two entire arteries going to the neck, and which come off immediately after the thyroid, viz. the cervicalis profunda more constant, and the cervicalis superficialis which is less regular.

### 6. ARTERIA INTERCOSTALIS SUPERIOR.

The UPPER INTERCOSTAL is given to supply the intercostal space betwixt the two uppermost ribs, because the aorta which gives out all the other intercostals, regularly one for each rib, does not begin to give them off till after it has made its turn downwards; of course it leaves the two upper ribs without arteries. To supply this, then, is the office of the superior intercostal artery, which is about the size of a crow-quill, and goes off from the subclavian generally next after the vertebral and thyroid arteries. It comes from the upper and back surface of the subclavian trunk; it turns downwards and backwards, and lodges itself by the side of the spine in the hollow where the spine and the first rib are joined, and where the first thoracic ganglion of the great intercostal nerve lies. Before it takes its place betwixt the ribs, as the intercostal of the two upper spaces, it sends a branch upwards upon the face of the lower vertebræ of the neck, which is given to the scaleni, to the longus colli muscle, and to the nerves: next it gives off the highest intercostal artery for the space betwixt the first and second ribs, which artery divides into two branches; one perforates the thorax, and goes out upon the back, and supplies the muscles which lie flat upon the back of the chest; while another branch, the proper intercostal branch, runs along betwixt the ribs.

Next it gives off a second intercostal artery, which also has its external and internal branches, and of which a branch inosculates over the third rib with the uppermost intercostal of the aorta. Besides these, it gives also small branches to the œsophagus, which inosculate with the tracheal arteries; and it gives branches to the spinal marrow, which pass into the canal along the holes for the nerves; and which not only supply the sheath, but also inosculate with the arteries of the spinal marrow itself.

## 7. ARTERIA SUPRA-SCAPULARIS.

The SUPRA-SCAPULAR ARTERY, or the superior scapular artery, is one of such magnitude, and is so different in size and destination from the cervical and other small arteries of the neck, that it ought to be described apart: though of great size and importance, it is yet so little known, that Sabbatier does not even describe nor name it.

The SUPRA-SCAPULAR ARTERY very often comes off from the THYROID artery; in which case it is the last in order of all the branches of the thyroid, that is to say, the nearest to the shoulder, and then it is named TRANSVERSALIS HUMERI, because of its going across the root of the neck of the shoulder. Sometimes it arises from the cervicalis superficialis; but then it is a small artery, and in such cases it reaches no further than the tip of the shoulder, and does not descend to the scapula. Often I see it arising as a distinct artery, large, very long, and tortuous; running across the root of the neck, till at the top of the shoulder it dives under the acromion process; and then passing over the notch of the scapula, supplies all the flesh of its upper surface.

The reason of my naming it supra-scapular artery, is its passing thus over the scapula, while another, the largest branch of all those proceeding from the axillary artery, is named sub-scapularis, from passing under the scapula.

To repeat the origin then of this supra-scapular artery; it arises sometimes as an independent artery, and is so great, that we wonder that it does not always do so: often it arises from the thyroid, is its last branch, and is named TRANSVERSALIS HUMERI, authors not observing that it belongs absolutely to the scapula; it rarely arises from the cervicalis superficialis; and when it does so, it is small: often in a strong man it arises apart; and when it does arise from the thyroid or cervical arteries, it is often so large as to

annihilate as it were all the other branches of the artery from which it arises.

Where this artery passes out of the chest it is covered only by the root of the mastoid muscle; and it gives twigs to the mastoid, to the muscles which ascend to the throat, to the subclavian muscle, to the fat, jugular vein, and skin.

Next it gives a superficial branch to the skin, trapezius, and other superficial parts about the shoulder.

Next it turns over the acromion process, passes through the supra-scapular notch, with many windings and contortions; spreads itself over all the outer surface of the scapula, both above and below the spine, and is the sole supra-scapular artery. The manner of its spreading is this: having passed over the ligamentum proprium posterius scapulæ, for it very seldom passes through the notch, and near the supra-scapular nerve, it lies flat upon the scapula, it sends off two branches, one on either hand at right angles; and of these one goes along the upper border of the scapula towards its basis, the other goes in the other direction towards the shoulder-joint, and circles round the upper side of the spine or ridge of the scapula.

The main artery having first passed the scapular notch, and given these two small branches, next makes a second perforation, viz. by passing under the root of the acromion process; and then it again divides into large branches in which it ends. The one branch runs all along the root or base of the spine or high ridge; the other branch runs nearly in the same direction, but lower down, viz. nearer that edge where the great sub-scapular artery runs; and with which, of course, it makes many free inosculations.

This artery lies so across the neck that it may be cut, especially in wounds with the sabre; and in a big man it is of such size as to pour out a great quantity of blood. It is necessary for the surgeon to remember the great size of this supra-scapular artery,

its long course over the shoulder, at what place it arises within the chest, and how it may be compressed. But in another sense also it is peculiarly important; for the supra-scapular artery makes inosculations with the lower scapular artery, freer, and fuller, than in almost any other part of any limb. One can hardly force tepid water through those small arteries which support the arm after the operation for aneurism; but the inosculations of this supra-scapular artery are so free, that often, though I have tied the arteries with great care, the very coarsest injection has gone round by it; and when I desired only to inject the head, I have found the arteries of the arm entirely filled. The conclusion which this leads to in wounds of the axillary artery is too obvious to need any further explanation.

RECAPITULATION AND PLAN OF THE BRANCHES OF THE

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| THYROIDEA INFERIOR. | 1. *Transversalis Humeri or Supra-Scapularis.** |
| | 2. *Transversalis Colli.* |
| | 3. *Thyroideæ Ascendens.* |
| | 4. *Ramus Thyroideæ Thyroideus, or Proprius.* |

GENERAL PLAN OF THE PRIMARY BRANCHES OF THE

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| SUBCLAVIAN ARTERY. | 1. *Arteria Mammaria Interna.* |
| | 2. *Arteria Thyroidea Inferior.* |
| | 3. *Arteria Intercostalis Superior.* |
| | 4. *Arteria Vertebralis.* |
| | 5. *Arteria Cervicalis Profunda.* |
| | 6. *Arteria Cervicalis Superficialis.* |

## II. OF THE AXILLARY ARTERY.

This artery assumes the name of axillary, where it lies in the arm-pit or axilla. The scaleni muscles being attached to the ribs, the artery passes first through betwixt the first and second scalenus; next

* As my reader has seen, this artery comes off sometimes from the subclavian as a distinct branch; and then its size in a manner deranges the relative magnitude of the other branches.

it passes out from under the arch of the clavicle, where it was protected: then it falls over the breast in a very oblique direction; it inclines outwards towards the axilla, lies flat upon the slanting convexity of the chest, is covered by the pectoral muscles, and the great pectoral muscle arises from the clavicle, under which the artery passes; but far from being protected, it is so far exposed as to be easily felt beating, and it is at this point only that it can be rightly compressed. It declines still outwards and downwards, till at last it gets so deep into the arm-pit, and so much under the scapula, as to lie betwixt the serratus anticus and sub-scapular muscles. There it is rightly called the axillary artery. In this hollow it lies safe, protected by the deep borders of the pectoral muscle before, and of the latissimus dorsi behind, surrounded with fat and glands, inclosed within the meshes of the plexus, or great conjunction of nerves, which go to the arm, surrounded also by all the veins of the arm, which twine round it in a wonderful manner. Here it gives off the thoracic arteries to the thorax, and the scapular arteries to the shoulder. In short, the axilla itself is a complicated study; but in all that respects the arteries it may be made very easy and plain. But let the surgeon remember that it is only by a perfect knowledge of the arteries, a bold stroke of the knife, and a masterly use of the needle, that the patient is to be saved from bleedings after wounds hereabouts: for the old story of compressing the axillary artery above the clavicle is now of no credit with any surgeon of knowledge or good sense.

As the artery turns over the borders of the chest, it gives one or two twigs to the adjacent parts, as to the scaleni, and to the great nerves which lie over the artery, and to the serrated muscle, where it lies under the scapula: but these branches are so small that it is unnecessary either to number or describe them. The thoracic or external mammary arteries are the first important branches; they are four in

number, and they are named after their place or office.

### 1. ARTERIA THORACICA SUPERIOR.

The UPPER THORACIC ARTERY, being the first, lies of course deep in the axilla. It comes off about the place of the first or second rib; it lies betwixt the lesser pectoral and the great serrated muscle; it gives its chief branches to these muscles, and it also gives other branches to the intercostal muscles and the spaces betwixt the ribs. But, upon the whole, it lies very deep, is small, and is so short that the next is entitled thoracica longior: it is an artery of little note.

### 2. ARTERIA THORACICA LONGIOR.

The LONG THORACIC ARTERY is more important, supplying all the great pectoral muscles and the mamma. It was named the external mammary artery; but we are the more willing to change the name, since it has no likeness to the internal mammary artery, is in no respect a counterpart to it; it might be named the pectoral artery. It is long, not tortuous, but straight and slender, and about the size of a crow-quill. It is needless to describe an artery so variable in its branches as this is; it is sufficient to say, that after giving small twigs to the axillary glands, it terminates with all its larger branches in the pectoral muscle, mamma, and skin, and in inosculations with the intercostals and internal mammary; it is very long, descending sometimes so low as to gives branches to the oblique muscles of the belly.

### 3. ARTERIA THORACICA HUMERARIA.

The THORACIC ARTERY of the shoulder goes off from the upper and fore part of the axillary artery. Its place is exactly opposite to that of the mammaria

externa, viz. under the point of the coracoid process, insomuch that Haller has named it thoracica acromialis. It is a short, thick artery; it bursts through the interstice between the pectoral and deltoid muscles, and appears upon the shoulder almost as soon as it comes off from the main artery; it resembles the thyroid in shape, being a short thick artery, terminating all at once in a leash of slender branches, which go over the shoulder in various directions; but I never could observe any order worth describing. One deeper branch goes to the serratus major, a branch goes along the clavicle, gives it the nutritious artery, and then goes on to the pectoral muscle, and to the skin of the breast: it gives small branches to the axillary glands, and larger ones to the deltoid and pectoral muscles and skin of the shoulder, for this is very much a cutaneous artery. The chief branch is that which is last named, running down betwixt the deltoid and pectoral muscles; and the most curious branch is a small artery which accompanies the cephalic vein, and runs backwards along the course of the vein, a small and beautiful branch.

### 4. ARTERIA THORACICA ALARIS.

Sometimes, though not always, there is a fourth thoracic artery. When it exists, we find it close by the last artery; its branches, which are sometimes numerous, belong entirely to the cup or hollow of the axilla; it goes to the glands and fat, and thence its name of ALARIS or AXILLARIS. This is the deepest or backmost of these mammary arteries; it attaches itself to the lower border of the scapula, and we often see it running along the lower border a considerable length, and giving branches chiefly to the sub-scapularis muscle.

These are the four mammary arteries which go to the breast. The arteries which go to the scapula follow next, and are only three in number; one, which is the counterpart of the supra-scapular artery,

is the greatest branch from the axillary artery, supplies the lower surface of the scapula, and thence is named SUB-SCAPULAR ARTERY; one, which, as it is reflected round the joint by the outside, is named the EXTERNAL CIRCUMFLEX ARTERY; and one, which, as it turns round the inner side of the joint, is named the INTERNAL CIRCUMFLEX ARTERY.

### 5. ARTERIA SUB-SCAPULARIS.

The SUB-SCAPULAR ARTERY is of a great size; it is hardly described in books, I might say was hardly known to the older anatomists. Douglas, and most especially Sabbatier, have scarcely named it, though it is in fact one of the largest arteries in the body, being nearly as large as the axillary artery, from which it takes its rise.*

The greatest mass of flesh in almost any part of the body is that which lies under and around the scapula in a strong man; and this artery supplies almost all that mass. It goes off from the axillary opposite to the neck of the scapula, just under the short head of the biceps brachii: it no sooner comes off from the axillary artery, than it attaches itself to the lower border of the scapula; and as soon as it comes to the edge of the scapula (but sometimes lower down the edge, viz. where the head of the triceps comes off,) it splits into two great branches; one of which goes to the upper, and one to the lower surface. But to describe each little artery among such a mass of flesh, or to expect to find them regular, would be very thoughtless; the general course of them only can be described. First, The greater branch, which goes to the lower surface of the scapula, is the proper trunk of the sub-scapular artery;

* It is named often scapularis inferior or infra-scapularis; it is better named sub-scapular, both to harmonize with the name sub-scapular muscle, to which it belongs, and also to contrast with its counterpart, the supra-scapular artery, which comes from the sub-clavian artery.

it divides into two great branches, which course all over the lower or hollow surface of the scapula: one of these is deeper, runs downwards along the naked border of the scapula, lies under the muscles upon the flat bone, and supplies the inner surface of the sub-scapular muscle with many branches. It sends a branch upwards, which runs along the inner surface of the neck of the scapula, runs still forwards under the root of the coracoid process, and its extreme branch goes round by the basis of the scapula to make an inosculation with the larger branch.

Secondly, The larger branch keeps nearer the surface, and supplies all the outer side of the sub-scapular muscle. Its general course is round the scapula, down the fore edge, then round by the lower angle, then up by the line of the basis scapulæ, encircling it with what might be named a coronary artery. It first gives branches to the teres major; then passes down along that muscle to the angle of the scapula; then turning along the angle of the scapula (which it does not do without leaving many branches behind,) it runs in a waving line all round the basis scapulæ, till it arrives at the upper corner, where it ends in free inosculations, both with its own deeper branch, and also with the supra-scapular artery which comes along the shoulder.

Now this great branch, with all its arteries, belongs entirely to the lower surface of the scapula; but the branch which leaves it at the neck of the scapula turns round under its lower edge, gets to the upper surface of the scapula, runs in under the infra-spinatus and teres minor muscles, betwixt them and the bone; and although the supra-scapular artery from the shoulder supplies chiefly the upper part of the scapula, yet it is chiefly above the spine that that artery circulates, while the lower parts of the infra-spinatus and the teres minor muscles are left to be supplied by this reflected branch of the sub-scapular artery: thus this reflected branch gives its arteries, first to the teres, then it enters into the hollow under

the spine, and besides supplying the infra-spinatus and the bone itself, it also makes a circle, though a shorter one, and inosculates with the supra-scapularis, just as the other branch of this same artery does on its lower surface. This branch descends nearly to the corner of the scapula before it begins this inosculating circle; but it sends also another chief branch round the neck of the scapula, which advancing towards the supra-scapular notch, inosculates very largely with the supra-scapular artery.

Thus is the scapula encircled, and supplied with a wonderful profusion of blood by two great arteries; one, the SUPRA-SCAPULAR ARTERY, coming across the neck, over the shoulder, and through the scapular notch; another, the SUB-SCAPULAR ARTERY, which comes from the axilla to the lower flat surface of the scapula, and divides at the edge of the scapula into two great branches; one of which keeps still to the flat surface, while the other turns over the edge of the scapula, and supplies in part its upper or outer surface.

If instead of attending to the branches of this artery, in the order of their size and importance, but according to their most common succession; then this will be the plan.

SUB-SCAPULARIS.
SCAPULARIS INFERIOR.

1. *Ramus Muscularis Irregularis.*
2. *Ramus Circumflexus Scapularis.*
3. *Ramus Dorsalis Scapulæ Superior.*
4. *Ramus Dorsalis Scapulæ Inferior.*
5. *Ramus Sub-scapularis.*

### 6. ARTERIA CIRCUMFLEXA POSTERIOR.

The POSTERIOR CIRCUMFLEX ARTERY is a very large one. It arises either along with, or immediately after, the great sub-scapular artery; the place of it is of course settled by the place of the shoulder-joint, for it belongs so peculiarly to it that it is sometimes named the Humeralis, sometimes the Articularis, sometimes the Reflexa Humeri. It goes off between

the sub-scapularis and teres major muscles ; it passes in between them to get to the joint; it then turns round the shoulder-bone, accompanied by the circumflex nerves, just as the supra-scapular artery is accompanied by the supra-scapular nerve ; it ends, after having made nearly a perfect circle, upon the inner surface of the deltoid muscle.

Its branches are, first, Twigs to the nerve which accompanies it, and to the capsule of the shoulder-joint. Secondly, Branches to the coraco-brachialis and short head of the biceps, and to the triceps, and a twig to that groove in which the tendon of the long head of the biceps lies. Thirdly, It sends large branches to the sub-scapularis, to the long head of the triceps, &c. And lastly, The artery, far from being exhausted by these branches, goes round the bone, turns over the joint under the deltoid muscle, and ends in a great number of branches, still accompanied by branches of the nerve, which are distributed in part to the capsule, but chiefly to the lower surface of the deltoid muscle, where it lies upon the joint.

### 7. ARTERIA CIRCUMFLEXA ANTERIOR.

The ANTERIOR CIRCUMFLEX ARTERY, which goes round the fore part of the joint, bears no kind of proportion to that great artery which passes round the back. The anterior goes off from the same point nearly with the posterior, or sometimes arises from the posterior itself; it takes a direction exactly opposite; it keeps close to the shoulder-bone, passes under the heads of the coraco-brachialis and biceps; encircles the head of the os humeri just at the root of the capsular ligament, and goes round till it meets and inosculates with the posterior circumflex artery. I never could find those muscular branches which are said to go to the scapula, or have found them very trivial; the whole artery belongs to the bone and its parts; it encircles the root of the cap-

sule with a sort of coronary artery; it gives twigs to the capsule, the periosteum, and the tendons, which are implanted into the head of the bone; and having given twigs to the heads of the biceps and coraco-brachialis, it gives off its only remarkable branch, which is indeed regular and curious; it is a small branch which runs down along the bone in the groove in which the tendon of the biceps lies.

PLAN OF THE

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| | 1. *Arteria Thoracica Superior.* |
| | 2. *Arteria Thoracica Longior.* |
| | 3. *Arteria Thoracica Humeraria.* |
| ARTERIA AXILLARIS. | 4. *Arteria Thoracica Axillaris.* |
| | 5. *Arteria Sub-scapularis.* |
| | 6. *Arteria Circumflexa Posterior.* |
| | 7. *Arteria Circumflexa Anterior.* |

Concerning the axillary artery in general, there is more to be observed than this occasion will allow. But these things must not be passed over in total silence. In the first place, the artery, as it passes over the border of the chest, and after leaving the arch of the clavicle, is felt beating, and there it can be compressed.

The compressing of the subclavian artery with a tourniquet or with the thumb, attracted at one time so much attention, and incited so many to speak about it, that it came to be thought important, and has been ever since esteemed practicable; and yet even those who have spoken the most confidently have taken the thing merely upon vague report, have neglected to read the proper books, have described the way of compressing as above the clavicle, not knowing that it should be done below it. Camper, in his "Fabrica Brachii Humani," first mentioned what he had demonstrated in his class, viz. that he could, by placing the thumb under the point of the coracoid process, so compress the axillary artery against the second rib where it lies upon it, that even the strength of a syringe could not push an in-

jection through it.* And those who learn things by hearsay, have said that "the subclavian artery could be compressed by thrusting the thumb in above the clavicle;" although, in fact, the arch is so deep, the muscles so strong, and the artery so little exposed, that this is absolutely impossible.

From my speaking with a seeming interest about the preference of one of these two places to the other, it may be thought that I believe this piece of knowledge useful: quite the reverse! I know it to be dangerous; I know it to be less practicable than authors report and believe; and I repeat what I said on a former occasion, that "it is easy to stop the pulse of an artery, but quite another matter to stop the flow of blood through it." We thrust down our hands and compresses, and rest with our whole weight upon the artery; it seems stopped, because the pulse is stopped; but the first stroke of the knife shows us how far we are gone in a dangerous mistake. I may say, without breach of confidence, that I have seen one gentleman trust to it, who will never trouble himself about it again. He was a dexterous surgeon; and in a great aneurism of the axilla was deluged with blood at the first stroke of the knife, and saved his patient only by a plunge of the great needle.

Secondly, It is much to be lamented that we cannot really suppress the blood; not merely because it would make every wound less dangerous, but because

* In cadaveribus plus semel in publico theatro monstravi, comprimi posse integram arteriam; ligabam arteriam aortam infra arcum, resecabam deinde axillarem dextram, ac siphone axillari sinistræ adaptata fortiter aquam impellens, solo digito eo modo moderare potui subclaviam, ut ne gutta quidem efflueret; quod quanti momenti esse queat in amputatione humeri in articulo nemo non videt. In vulneribus sclopetariis, aliisque circa humeri articulum inflictis, sanguinis profusionem similiter compescere, si non penitus sistere possemus. Vid. *Camper*, lib. i. p. 15.—The plain reason why we are able thus to compress the artery in the dead subject is the want of resistance in all the muscles. If ever it be possible in the living body, it must be when the strength is low, and the circulation very languid, after the patient has fainted with loss of blood.

it would greatly facilitate operations which we are called upon every day to perform. Would it not be pleasant if we could cut the cancerous breast without the loss of blood? or search into the axilla with perfect deliberation, and cut diseased parts out with the knife, not tearing them in a seeming brutal manner with our fingers? Let the surgeon, instead of trusting to the narration of authors, try the compression of the subclavian artery, in the amputation of the breast, an operation more familiar, and he will learn to appreciate the value of this compression; he will find that the bleeding is as profuse as if no such compression were made. Yet still, by studying this piece of anatomy, the surgeon knows both from what source all the arteries which bleed upon the surface of the amputated breast come; and also that in any very dangerous situation it would be easy to command all the bleeding orifices by one dip of the needle, the axilla being open. He also knows that the thoracica alaris and the short thoracic artery supply all the glands, and that these lurk too deep in the axilla to be secured otherwise than by the compress: so that these arteries are in fact opened by tearing with the fingers, and are stopped by thrusting in a sponge. He knows also how many large arteries there are, especially about the scapula, of which the bleeding must resemble that of the axillary artery itself; he will judge of the nature of the wound by the pulse; and he will act with great advantage in all doubtful cases, by remembering these great arteries of the scapula, which either bleed outwardly most furiously, or if they seem to stop, it is only by filling the axilla with blood.

Thirdly, The connection of the artery with the axillary nerves, though it must be more fully described in another place, must yet be observed here as a relation too important to be omitted. The artery passes along with the nerves through the interstice of the scaleni muscles; the nerves, which consist of no less than nine, make by their mutual connections a

sort of net, which is called the plexus of the axillary nerves. This plexus has its meshes formed, not by small divisions, but chiefly by the seven great cords. This broad plexus lies over the artery as it comes out from the chest; the artery perforates the plexus, or passes through one of the largest meshes in the cavity of the axilla; and when we extend the arm, for example, to cut out an axillary gland, the great veins lie nearest the knife, or lowest in the axilla; the plexus of nerves next; and last of all the artery which has just perforated the plexus of these great nervous cords; three nerves are below the artery and two above; and when the arm is luxated, and the shoulder-bone pushed downwards, the head of it is so pressed against the net of nerves, and the artery is so compressed betwixt the head of the bone and the mesh of nerves, that I have very seldom failed to find the pulse almost entirely suppressed in luxations of this kind.

This connection, viz. with the nerves, is a very interesting one. It is plainly such that the artery cannot be hurt without a wound of the nerves; it has never been known that the artery has been cut in the axilla without the arm being lamed by this wound of the nerves: also the nerves cannot be hurt without the artery being in danger; but it does escape sometimes; of which, among other examples, this is one of the most singular. — I have seen the artery escape in wounds when the nerves were hurt; but how it could escape the stroke of a blockhead's needle in the following case, I am at a loss to conceive. A woman came to me with a great string hanging in her axilla, and along with her came her surgeon. He had about three months before cut off her breast for a cancer, and moreover some glands from the axilla, from which there was a bleeding; and of course, as his fingers could not go deep enough, he took a needle proportionably large, struck it down into the arm-pit, and tied all up. When he brought his patient to me, there hung from the arm-pit, not a surgical ligature, but a good large tape; the axilla was a large gaping

and terribly fetid ulcer; I passed my finger into it, and felt the arteries beating around it, and the tape firm about some cord of nerves, whether one or more I could not tell; the woman's fingers were as crooked as a bird's talon, and her arm hung by her side quite useless and lame. I made the surgeon feel the nerve with his finger, offered to cut out the ligature safely; but he carried away his patient, that he might, though at a long interval, finish the operation himself.

The breast had been long healed, and the cord acted as an issue in the axilla. How near the edges of this needle must have been to the great artery, it is terrible to think; and it is most providential that such accidents do not happen daily, considering how much this crooked needle is used in deep places, where it is least fit to be used.

## III. OF THE BRACHIAL ARTERY.

The brachial artery is that division of the artery which is marked by the tendon of the great pectoral muscle: for as that is the fore border of the axilla, all above that is axillary, and all below it brachial artery, down to the bend of the arm, where it divides into the radial and ulnar arteries. The brachial artery runs on the inner side of the os humeri, here the bone is most naked; and this is the line in which we feel the artery beating, and apply the cushion of the tourniquet.

To describe, as some authors have done, each insignificant and nameless branch which this artery gives off, were to make a simple matter intricate beyond all enduring. The whole matter is this: As the artery goes downwards, lying exactly on the inner side of the arm-bone, and directly in the middle betwixt the biceps on the fore part and the triceps behind, it gives frequent branches to each. Those going to the biceps are short, small, pretty regular, and exceedingly like each other all the way down the arm; and they are thus frequent, and very short, in consequence

of the artery adhering closer to the sides of the biceps. Not one of them can be distinguished, or is worth naming. Those which it sends downwards to the triceps are (in consequence of that being a large muscle, with several thick and fleshy origins) both longer and more tortuous, and more important; and they accordingly have some of them appropriate names. Of these arteries going down towards the back part of the arm, and working their way among the muscles, three chiefly are to be observed. First, The arteria profunda superior, which goes round the back of the arm to the exterior muscles, and is often named the upper muscular artery. Secondly, Another like it, called arteria profunda inferior, or the lower muscular artery. Thirdly, The ramus anastomoticus major, which anastomoses round the elbow with the branches of the ulnar artery. These three chiefly deserve notice.

## ARTERIA PROFUNDA HUMERI SUPERIOR.

Those arteries, which in the limbs go deep among the fleshy parts, as in the arm or thigh, have always one of two names, either profunda or muscularis, and often both. The upper deep muscular artery of the arm is about the size of a crow-quill, or larger; it goes off from the inner side of the brachial artery, just where the tendons of the latissimus dorsi and teres are inserted; and very often it arises from the great artery of the scapula, or that of the joint, viz. the sub-scapularis, or reflexa humeri.

The PROFUNDA turns downwards and backwards round the bone; it glides in betwixt the first and second head of the triceps; there it divides within the thick flesh of that muscle into two chief branches, or the two branches sometimes part immediately after their common origin, or sometimes they go off apart from the humeral artery. One of these, perforating the biceps muscle, turns quite round the bone; and Monro the Father, who gave us the name of spiral

nerve, named this also, very properly, the muscular spiral artery: so this artery also, as well as the suprascapular and circumflex arteries, has its accompanying nerve. This long artery runs down the back and outside of the arm; it descends quite to the outer condyle of the os humeri, and by branches round the olecranon, and over the outer condyle, it inosculates very freely with the radial artery.

The other branch of the profunda superior runs down the inner side of the arm, gives many branches to the triceps, and coraco-brachialis; gives a few also to the biceps and deltoid muscle: its longest branch, the proper termination of the artery, runs downwards till it touches the inner condyle, as the posterior branch does the outer condyle; and this inner artery communicates with the outer branch round the olecranon, making small but frequent and beautiful inosculations; and it also inosculates over the condyle with the reflected branch of the ulnar artery. In short, the profunda superior turns down towards the back part of the arm, buries itself under the triceps muscle, supplies all the flesh of the triceps, and divides in the heart of that muscle into two branches, both of which go down to the elbow-joint, and inosculate; the one, round the outer condyle with the radial artery; the other, round the inner condyle with the ulnar artery.

### 2. ARTERIA PROFUNDA HUMERI INFERIOR VEL MINOR.

The LESSER PROFUNDA, or the lower muscular artery, is so named because it resembles the former in almost all points. It is smaller, being not half the size (viz. of a crow-quill), and goes off, in general, about two inches lower down the arm. Its course, also, is exactly similar, except in this, that it is single, does not divide into two branches; it gives twigs to the muscles of the arm; runs down to the inner condyle, and after touching it, makes a sudden and serpentine turn, by which it gets upon the back part of

the elbow-joint. Its chief inosculations are with the upper profunda, and with the recurrens interossea upon the back part of the joint.

Betwixt the upper and lower profunda there generally is sent off that artery which is to nourish the bone. It is named ARTERIA NUTRITIA HUMERI ; but is not of sufficient importance to be numbered among the main branches of the artery. The nutritious artery sends off small branches, or rather small twigs, to the brachialis, or that muscle which lies under the biceps and to the triceps; and it perforates the bone about its middle in one larger artery, and sometimes there are also one or two smaller ones.

### 3. RAMUS ANASTOMOTICUS MAJOR.

The GREATER ANASTOMOSING ARTERY is one of three or four which anastomose round the elbow-joint; for as the humeral artery advances towards the bend of the arm, it begins about three inches above it, to give off sideways, and almost at right angles with the trunk, three or four small arteries, more or fewer according to the size of the arm. Each of these sends its little twigs round the condyle, to inosculate with the arteries of the fore-arm both radial and ulnar. Among these, one is distinguished for its size and importance ; it is one of the largest of these arteries, and thence named ANASTOMOTICUS MAGNUS ; it arises from the humeral artery about three inches above the joint; it lies close by the side of the brachialis internus, and gives many branches to it and to the triceps ; but it is chiefly expended in three branches, one of which turns backwards, and running up the arm, gives branches to the muscles, and inosculates with the profunda : another goes downwards towards the middle of the bend of the arm, and gives branches to the pronator teres and the flexor digitorum ; and then going deeper, it touches the capsule, and makes a beautiful inosculation over the fore part of the joint with the radial recurrent or inosculating artery ;

another branch, the most important, and the chief termination of the artery, runs down betwixt the olecranon and the condyle, in the hollow where the ulnar nerve lies. It first contributes to that net-work of inosculations which covers the back of the joint over the olecranon; it inosculates very freely with the recurrens ulnaris; and it is this inosculation that gives the artery its importance and its name. This is the channel through which the blood goes after the operation for the aneurism, as we know from preparations; and I have several times felt for it, and found it after the operation, while the arm was still very small, having been wasted by the disease and by the suppuration.

I have not, in describing these arteries of the arm, once mentioned the name of collateral artery; for it is a name which must be entirely dropped, because it has been much abused. Sabatier, Murray, Haller, and all the French and German anatomists, have named the arteriæ profundæ COLLATERAL ARTERIES; because they lie alongside of the great artery, running along with it down the arm. Douglas, and the English anatomists and surgeons, have called the three or four short anastomosing branches near the elbow the collateral arteries; because, though they run off at right angles or obliquely from the trunk, yet they run parallel with each other. Dropping this name, then, we find no more than three arteries in the arm, of any note: the upper or greater profunda, with its two branches; the lower or lesser profunda; and the great anastomosing artery.

We are obliged to add, however, that the branches of the humeral or brachial artery are exceedingly irregular.

RECAPITULATION AND PLAN OF THE

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|---|---|
| ARTERIA BRACHIALIS. | 1. *Rami Musculares Irregulares.* |
| | 2. *Arteria Profunda Humeri Superior.* |
| | 3. *Arteria Profunda Humeri Inferior.* |
| | 4. *Anastomotica Magna.* |

## OF THE ARTERIES OF THE FORE-ARM, VIZ. OF THE RADIAL, ULNAR, AND INTEROSSEUS ARTERY.

The place and condition of this artery at the bend of the arm, is as interesting as where it lies in the axilla; for while bleeding is allowed, or is practised by low and ignorant people, operations at this point must be more frequent than at any other, and must be easy or successful only in proportion as the artery and all its relations are well understood.

The humeral artery still continues an undivided trunk, lower than the bend of the arm; though we are accustomed to name that as the place at which it divides. The whole arm, it must be remembered, is covered with a fascia, and that fascia lies over the artery; but at the bend of the arm there is a peculiar fascia, or at least the round tendon of the biceps so strengthens the general fascia, by sending a broad expansion obliquely across the bend of the arm (which fascia is fixed into the condyle and down the edge of the ulna,) that we call this expansion peculiarly the tendon of the biceps, and say that the artery is at the bend of the arm covered and protected by the tendon of the biceps muscle. The condition, then, of the artery is shortly this: it comes from the inside of the arm, inclining all along towards the middle of the bend or folding of the fore-arm; there, without any particular ring or aperture for its admission, it passes under the aponeurosis of the biceps muscle; for the aponeurosis of the biceps and of the arm in general are one continued sheath. When thus lodged behind the tendon, it lies in a deep hollow betwixt the flexors and extensors of the arm, or, in other words, betwixt the muscles of the upper and of the lower edge; the tendon of the biceps covers this triangular hollow; the floor or bottom of it is the coronary process of the ulna, and the fore part of the elbow-joint, and there the artery lies imbedded in cellular substance, encircled by those veins which accompany the artery

particularly, and which are thence named venæ comites; and it carries along with it a nerve in diameter equal to itself, and this nerve is named the great radial nerve.

The artery does not divide immediately, even after it has thus passed the bend of the arm, but goes down deep among the flesh of the fore-arm, and there divides; the ulnar artery being lodged under the thick flesh of the pronator and flexor sublimis muscles, and the radial artery under the strong fleshy belly of the flexor radialis and of the supinators, not absolutely within their substance, nor passing below them, but under cover of their fleshy bellies, which swell out into a great thickness at this part of the arm, and in a manner enclose the artery. The only part of the artery which is exposed, the point which we feel beating, is that where the single and undivided trunk first begins to pass under the thicker fascia of the biceps muscle; and there the artery is pushed forwards, raised, and made to appear superficial by the projection of the coronoid process and brachialis muscle, or, properly speaking, by the protrusion of the fore part of the elbow-joint. This is just before it sinks into the triangular hollow betwixt the muscles.

This artery is singular in one kind of lusus naturæ, which never happens, nor any thing similar to it in the lower extremity, viz. that the trunk of the artery forks into two great branches high in the arm; sometimes in the axilla, but often in the middle of the arm, or opposite to the pectoral muscle; and I have constantly observed, when this happened, that the radial artery was, as it were, the accidental branch, and passed across the arm near the bend of the elbow, so as to traverse the ulnar or main artery; and that the radial artery passes quite on the outside of the fascia, which binds down the ulnar or main branch of the artery.

This short description involves many points which the surgeon should think of, and more than can be

touched upon in this place. The following consequences certainly follow from this arrangement of parts.

First, The artery lying thus deep under the biceps, cannot be hurt by any skilful surgeon, though bleeding the very vein under which it beats, and at the most critical point; it is hurt, as far as I have observed, only by the rudest stroke of very ignorant fellows; I have seen in six cases a wound in it little less than a quarter of an inch in length. In one of the operations I found it absolutely transfixed; the blood had been poured out from the orifice behind; I felt with surprise the artery running over the tumour, not under it; and having opened the sac, I passed a probe through the artery from side to side.

Secondly, Since the artery divides only after it has gone deep, where its great branches are protected by the muscles of the fore-arm, the trunk only is wounded in bleeding; the branch is never wounded; and we cannot but be surprised that Hunter, Haller, Sharp, and others, who ought to have studied this point, believed it to be sometimes at least wounded in one of its branches; nor can we think, without surprise, of the arteries being so little understood in the time of Dr. Monro the Father, that he is forced to argue the propriety of doing the operation of aneurism from this fact, "That though it were dangerous to trust to the common anastomosis round the elbow, yet it sometimes happens, that the two branches of the radial and ulnar are set off in the axilla." This surely must have been but a cold assurance to the surgeon in those days, viz. that he was to trust chiefly to the chance of a lusus naturæ for the success of one of his greatest operations.

Thirdly, It must follow, since the artery lies behind the fascia, and is wounded through it, that the blood, being poured out behind the fascia, must raise it into a hard, firm, and (in time) inelastic tumour, growing every day firmer and harder. If surgeons will but think of this, they will go through their operation

more correctly. It makes a point of vast importance in the description of aneurism, since it gives outwardly the true character, and inwardly the true shape and appearance of the tumour, when the operation is begun, the outward incision being performed. Had it been but attended to rightly, what noise and wrangling might it not have saved about the nature and names of the disease (yet still the older surgeons knew and described this piece of anatomy, though they made but a poor use of it)? and what idle and stupid descriptions might it not have prevented, such as we have never seen in surgical books till now, of diffused aneurism, and the operation for diffused aneurism; when in truth the first stroke of the knife shows it to be a tumour very different from that which such names, and such formal divisions, and old-fashioned descriptions must convey? The cup of an aneurism is the triangular hollow which I have described, and the bag of the tumour is the extended fascia, with the cellular membrane extended, and bent into a firm capsule.

Fourthly, the course of this double artery tempts me to believe, that in those few cases where the blood of an aneurism was truly diffused, where it was an ecchymosis, where the blood was not confined by the fascia, but poured out under the skin, and driven upwards to the shoulder, and downwards to the fingers, giving the whole arm the appearance of mortification; that in such rare cases, there must have been a high division, and that the preternatural artery had been wounded, for it lies above the fascia, it is lodged in no hollow, such as might receive its blood, nor covered by any membrane which might confine it: but at all events, I am persuaded that Hunter is wrong in suspecting that, since the pulse so seldom returns instantly, this preternatural artery and the true one must be often tied together; for if the preternatural artery were wounded, it would be a very diffused aneurism, under the skin and above the fascia; but the main artery would be found in its

place, under the fascia, quite safe; whereas, if the true artery were wounded, the tumour would be under the true fascia, the preternatural artery would cross by the side of the tumour, over it, and the wounded artery being at the bottom of its own tumour, the two arteries would be a great way apart. Besides, the necessity of supposing this is not so strong as Hunter believed; I have seen the pulse return during the dressing of the arm, when the dissection was so wide and free that I am sure there could be no lusus naturæ, but one artery dividing in the common place.

Fifthly, The close connection of the artery with the great radial nerve must always be considered in all wounds at the bend of the arm; and especially it constitutes a difficulty in the operation of aneurism, of which authors of great eminence have spoken far too lightly; and surgeons of character have tied it in with their great ligatures, as if for amusement, or that they might see what would ensue. But, as I have said on another occasion, "a man must show me either some positive necessity for doing this, or some positive good consequences which will result from it, before I admit him to argue about the bad effects which may ensue." Will any man persuade me, after the case which I have just related, that it is good or harmless to tie in the largest nerve of the arm? We see by that case, that the ligature's remaining firm in its place for three months is one of the least of the ill consequences, and the others may easily be conceived. Of these ill consequences I have seen more than I will venture to tell.

The humeral artery having left this most critical point at the bending of the arm, divides into three great branches, the radial, ulnar, and interosseous arteries; at least the ulnar gives off the interosseus so soon, and the interosseus is so large, and has so pointed a destination, that I take the privilege of describing the three branches apart. The ULNAR

ARTERY, which we may regard as the continuation of the main artery, makes its way through the thickest flesh of the fore-arm, under the pronator teres, and the flexor digitorum sublimis, goes along the ulnar edge of the arm, appears again from under the edge of the flexor carpi radialis muscle, about three or four inches above the wrist; it goes down by the side of the pisiform bone into the palm of the hand, and to the root of the little finger, and gives the chief arches in the palm of the hand, and all the arteries of the fingers, saving only the side of the fore-finger. The RADIAL ARTERY goes off like a branch from the ulnar, or, in other words, the ulnar seems to continue in the course of the main artery, while the radial goes off to one side; it makes its appearance as a superficial artery much higher in the fore-arm than the ulnar does; it turns backwards over the wrist, or root of the thumb, and it gives all the arteries of the thumb and fore-finger, as the ulnar does of the other fingers. The INTEROSSEUS, again, is truly a branch from the ulnar; it comes off where the ulnar lies deepest; it runs along the interosseous membrane, whence its name; it belongs to the deep muscles of the arm.

These are the great divisions of the artery; but before entering upon these, it will be well to set apart and describe one particular set of arteries, viz. the recurrent; both because they belong in a peculiar manner to the joint, and because the recurrents, from whichsoever of the great arteries they come, still serve the same office, viz. of inosculating with those from the above joint; though, after all, this part of their office attracts our attention, chiefly because we depend upon these inosculations for our success in operations for aneurism, though unquestionably the chief use of these arteries is to supply the joint and adjacent parts; and there inosculations are but a secondary office.

### ARTERIÆ RECURRENTES.

The recurrent arteries are small arteries corresponding with the anastomosing arteries from above. They turn quickly backwards almost as soon as they are clear of the main arteries from which they arise: they encircle the whole joint, for they are no less than four, or sometimes five in number; one from the radial, two from the ulnar, and one from the interosseous artery.

### RECURRENS RADIALIS ANTERIOR.

The ANTERIOR RECURRENT of the RADIAL artery is the first branch which it sends off, excepting a small branch to the supinator and skin. The place where the radial recurrent is to be found, is deep in the hollow betwixt the brachialis internus muscle of the arm, and the extensor radialis or first muscle of the fore-arm, viz. that which constitutes its outer edge. The recurrent lies upon the fore part of the joint, where the outer condyle is; the muscles which lie over this recurrent artery, or near it, are the two flexors of the wrist, the supinator longus, and the biceps, and these receive its first branches; and one of its branches runs down along the tendon of the supinator. Its next branches go less regularly to the other muscles of the fore-arm, as to the pronator teres, and to the flexors of the fingers; it has one SUPERFICIAL ANASTOMOSING artery, whose anastomoses are not upon the naked joint; but, on the contrary, the branch mounts along the fore part of the brachialis internus muscle, and inosculates under the biceps with the lesser or lower profunda. A second anastomosing branch goes deeper; it passes through the flesh or belly of the brachialis, and anastomoses with the ramus anastomoticus major from above. A third anastomosing branch is the chief branch; it lies deeper still upon the fore part of the joint, in the hollow which I have

lately mentioned: it runs up under the belly of the supinator, along the fore part of the shoulder-bone, where it inosculates with the upper profunda humeri, and chiefly with its greater branch called spiral artery, which turns round the bone, and ends here over the outer condyle.

This is the recurrens anterior of the radial artery; but none of these branches have I ever seen or felt to be enlarged after operations for aneurism. The success of that operation depends entirely upon the arteries next to be described, viz. the ulnar recurrents, which are always two in number; but sometimes these two recurrents go off in one branch from the ulnar: in which case, viz. of a single recurrent coming off from the ulnar, it divides immediately into two branches, and the one takes the fore and the other the back part of the joint.

### RECURRENS ULNARIS ANTERIOR.

The ANTERIOR RECURRENT of the ULNAR artery goes off the first of the branches, immediately before it gives off the interosseous, and where the artery lies deep in its triangular hollow. This anterior artery passes up under cover of the pronator teres, lies close upon the fore part of the inner condyle, and is of importance, not only by its own size, but also by its anastomosing with the ramus anastomoticus major, which is the largest of the arteries from above.

### RECURRENS ULNARIS POSTERIOR.

The POSTERIOR RECURRENT of the ULNAR artery is often a branch of the anterior one, coming off with it in one common trunk. When it comes off apart, it arises a little lower; it is a larger and stronger artery, *i. e.* it makes as full inosculations, goes farther, and gives more branches to the muscles. This posterior recurrent arises from the ulnar at that place where it perforates the bellies of the flexor muscles; it also

dives through betwixt the two bellies of the flexor muscles of the fingers; it thus gets round the condyle, for these two muscles arise together, from the condyle: the artery gives many branches both to the pronator and flexor muscles, and to the periosteum, and capsule of the joint; it then lodges itself in that deep hollow which is betwixt the olecranon and the condyle, where the ulnar nerve lies (that nerve which we feel so benumbed when we strike the inner side of the elbow). The artery stretching upwards along the bone meets a similar descending branch from the upper profunda, and inosculates with it. As far as we yet know, the whole weight of the business in saving the arm after aneurisms depends upon these two arteries. In Mr. White's preparation it is the anterior branch which is enlarged, inosculating with the anastomoticus major over the fore part of the inner condyle. In a preparation which I have, it is the posterior artery which runs tortuous and enlarged behind the inner condyle: but I must add to the authenticity of this preparation, by noticing, that I have several times felt distinctly, after successful operations for the aneurism, that it was this posterior artery that was enlarged.

## RECURRENS INTEROSSEA.

The RECURRENT of the INTEROSSEOUS artery is the first of its branches, though sometimes this recurrent rises from the ulnar a little above the interosseous. This artery going to the middle and back part of the joint, is very constant; it first sends one smaller branch forwards towards the root of the brachialis internus muscle, which inosculates over the fore part of the joint with the ramus anastomoticus magnus, and with the ulnar and the radial recurrents; but these inosculations and this anterior branch are of small importance. The chief branch goes through that lacerated-like hole which is in the upper end of the interosseous ligament; and the artery having passed

through this hole, and got to the back of the joint, it runs for two inches upwards along the back of the olecranon, contributing greatly to form, by its inosculations with both branches of the profunda superior, that net-work of arteries which covers all the back part of the joint, and which belongs chiefly to the joint, to the capsule, and to the bones which form the joint.

From these anastomosing branches which belong to all the three arteries, we now return to describe the general course of the three great arteries; and first, of the radial.

## ARTERIA RADIALIS.

The RADIAL ARTERY is properly the first branch of the ulnar; it goes off from it at a pretty obtuse angle in the bend of the arm; it passes over the insertion of the pronator radii teres and under the edge of the supinator longus. It then takes its course to the wrist, parallel to the tendon of the flexor carpi radialis, and about a quarter of an inch to the outside of that tendon. It is here covered with a regular fascia. It is at the root of the thumb only that it divides into its great branches: and a clear proof that in its course down the fore-arm it gives off none but small and irregular muscular branches, is this, that it preserves almost an equal diameter in all its progress from the elbow to the wrist.

This is the artery which lies naked upon the radius at the wrist, where we feel the pulse. It lies more superficial, less imbedded in muscles, than the ulnar artery; for six inches above the wrist there is to be felt nothing but the naked artery, the sharp tendon of the supinator, and the bone. The radial artery, as to its course down towards the wrist, is direct; but with regard to itself, it is tortuous, with short and gentle wavings. Of its branches, as it moves down the fore-arm, there is not one that is worthy to be named. First, it gives a branch to the supinator,

and to the extensors of the carpus ; then it gives the radial recurrent, already described ; then, having gone a little deeper among the muscles, it repeats its branches to the supinator and extensors ; but being deep, it gives also twigs to the pronator and to the flexor radialis, inosculating with the interosseous arteries. Next, the radial artery, emerging from among the thickest of the muscles of the fore-arm, becomes superficial, touches the naked radius, and runs along it, with the belly of the flexor pollicis below it, and the long tendon of the supinator above it. Here are no muscles lying on the outside of it, nothing but the tendon ; and therefore all its twigs are downwards to the flexor pollicis, upon which it lies ; to the flexor digitorum, which lies next to that ; and to the flexor radialis and the palmaris longus. Next it gives deeper branches, viz. to the pronator quadratus ; and also it gives small twigs, which accompany the several tendons along the naked bone. Arrived at the wrist, it does not divide, as authors have represented, into two branches, viz. a palmar and a dorsal artery ; this is indeed a very rare occurrence : the radial artery passes on undivided to the root of the thumb, and there divides into three great branches ; one to the thumb, one to the fore-finger, and one to the palm of the hand : it does, indeed, while it is passing the wrist, give two considerable branches, one to the palm, and one to the back of the hand ; yet they are but branches.

### ARTERIA SUPERFICIALIS VOLÆ.

The first branch, then, of the radial artery, after arriving at the wrist, is that which goes across the palm of the hand, and may be named the SUPERFICIAL artery of the PALM. It goes off just where the main artery is about to turn over to the back of the hand ; it passes in general through the flesh of the thumb, going under the root of the ABDUCTOR BREVIS POLLICIS. This artery we generally find di-

viding into three branches: The first is a more superficial branch, which crosses the palm of the hand, and gives its twigs to the skin, palmar aponeurosis, annular ligament, and all the tendinous parts about the joint: The second is a larger and more important branch; it is the middle branch of these three; it goes deep; and having given several branches to the muscles about the root of the thumb, and to one or two of the interossei muscles, it makes a large inosculation with the great palmar arch, which seems to be indeed the chief tendency of the whole artery: The third branch is less regular than the others; it mounts along the root of the thumb, and belongs to its outer edge.*

The next branches of the radial artery are very small and nameless twigs, which go to the naked part of the wrist, to the tendons, ligaments, and the bones; and then comes the artery opposite to this artery of the palm, viz. the artery of the back of the hand.

### ARTERIA DORSALIS CARPI.

The ARTERY of the BACK of the HAND comes off from the radial, just after it has turned over the radial edge of the wrist. It takes its course directly across the back of the hand, over the carpal bones; and by its frequent inosculations with branches from the ulnar artery, and with the dorsalis metacarpi or dorsalis manus, it makes beautiful net-works across all the naked part of the back of the hand.

* This branch, anatomists have thought fit to call ARTERIA ULNARIS RADIALIS POLLICIS, which involves such a complication of contradictions, that, upon reading it, one would naturally turn to the table of errata. The artery is called radialis, because it comes from the radial artery; and ulnaris pollicis, because it goes upon the ulnar side of the thumb.

## DORSALIS METACARPI.

The RADIAL ARTERY, continuing its course under the extensor tendons of the thumb, sends off the dorsalis metacarpi, which is an artery generally larger than the last: it takes its course across the back of the hand and over the metacarpal bones, and from this artery are given off the interosseous arteries.

The first interosseous artery of the hand is large, long, goes up in a direct course to the fork betwixt the fore and mid-fingers, and plunges into the cleft of the digital artery at right angles with it. A second twig like this, and then a third, are given off; named the first, second, and third interosseous arteries: but they are all smaller than the first, and all the three communicate with the arteries from the palm.

Before the final division of the radial artery* into its three branches, it gives a third artery; or, as often happens, two arteries, to the back of the thumb.

## ARTERIA DORSALIS POLLICIS.

The small artery, or the two small arteries, which, from going along the back of the thumb, are named arteriæ dorsalis pollicis, come off either along with, or immediately after, the dorsalis carpi. When there are two, they run both along the back of the thumb, one on one side, the other on the opposite side; that which runs along the outer edge of the thumb passes through under the tendons, and is rather shorter; that which inclines to the inner side of the thumb is rather longer. These small arteries on the back inosculate round the edges of the thumb with the great artery on the inner side; which is next to be described.

* Notwithstanding the inconsistency of retaining the name of radial artery, after the artery has passed the wrist, and begun to run along the thumb, I venture to sacrifice verbal accuracy, and would make much greater sacrifices to obtain a clear arrangement.

Thus we have seen that the radial artery, having advanced to the wrist, turns quick round the wrist, over the head of the radius, and under the tendons of the thumb; it gives immediately before it passes, the artery of the palm; it gives immediately after it passes, the artery of the back of the wrist; it gives immediately after that, the artery to the back of the hand; and then the little arteries for the back of the thumb; it then mounts along the thumb in that hollow which is by the side of the metacarpal bone of the hand; and then the little arteries for the back of the thumb, till it arrives at the cleft betwixt the thumb and fore finger. Here it divides into three arteries; one to the inner side of the thumb, very large; another to that side of the fore finger which is next the thumb, which branch is much smaller; and one which exceeds these in importance, for it dives down into the palm of the hand, forms what is called the deep arch of the palm; and which, having crossed the palm, forms on the side next the little finger, that inosculation betwixt the upper and lower arches which is so much celebrated.

### ARTERIA RADIALIS INDICIS.

The artery of the fore finger proceeding from the radial artery is the first and smallest of these three branches. It goes off at the root of the metacarpal bone of the fore finger, goes up along its interosseous muscle, and runs along all the edge of the fore finger next the thumb, inosculating with the artery of the opposite edge, which comes from the ulnar arch: it sends off twigs at its root, which inosculate with the small dorsal arteries of the thumb; and it gives a branch to the abductor indicis.

### ARTERIA MAGNA POLLICIS.

The CHIEF ARTERY of the THUMB rises along its metacarpal bone, a single artery, and there splits com-

monly, I think, into three smaller branches. Two of these run along the fore part of the thumb up to its extremity, and inosculate there; the one running along the radial, the other along the ulnar side, till they meet at the point. These are, as it were, counterparts of the dorsal arteries, but greatly larger; the thumb being naked on the back, but fleshy where it looks towards the palm. Another branch of the arteria pollicis is one which turns to the palm of the hand, and runs towards the fore finger.

### ARTERIA PALMARIS PROFUNDA.

The third branch of the radial artery and that by which it ends, immediately succeeds the artery of the thumb. It crosses the palm of the hand so as to form the deep arterial arch, or the radial arch of the palm; it lies under the aponeurosis, and all the tendons and muscles, close upon the metacarpal bones. Having gone its circle so as to complete the arch, and having arrived at the root of the little finger, or rather lower, near the pisiform bone, it turns backwards with a sudden serpentine turn, and enters into the side of the ulnar arch, so as to make a complete inosculation.

This deep palmar arch gives out many arteries; but as it lies close upon the bones, they are all of the smallest order of arteries, and go only to the bones, and to the joints of the carpus and metacarpus. Those branches, again, which run upwards, give little arteries to the interossei muscles, to the lumbricales, to the long tendons, and to the interstice of each bone. Small twigs are sent through to the back of the hand, which are named arteriæ perforantes, and which inosculate with the dorsalis carpi, or artery of the back of the wrist; they also inosculate with the arteries of the fingers.

PLAN OF THE

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|---|---|---|
| ARTERIA RADIALIS. | 1. *Ramus ad Musculum Supinatorem.* | |
| | 2. *Arteria Recurrens Radialis.* | |
| | 3. *Rami Musculares Irregulares.* | |
| | 4. *Arteria Superficialis Volæ.* | |
| | 5. *Arteria Dorsalis Pollicis.* | |
| | 6. *Arteria Dorsalis Carpi.* | *Dorsalis Metacarpi.* |
| | 7. *Arteria Magna Pollicis.* | *Ramus ad Indicem.* |
| | 8. *Arteria Radialis Indicis.* | |
| | 9. *Ramus Anastomoticus Ulnaris Superficialis.* | |
| | 10. *Ramus Anastomoticus Profundus.* | |

## ARTERIA ULNARIS.

The ULNAR ARTERY, both from its size and its direction, is to be considered as the continued trunk of the humeral artery. It dives downwards and backwards into the triangular hollow which has been described, till it touches the interosseous membrane: it first gives off a small branch to the pronator teres and common origin of the flexor muscles, before it passes through them: sometimes it gives off here the recurrent which should come from the interosseous artery; in which case that branch, as it passes backwards through the interosseous membrane, is named interossea posterior suprema. Next the ulnar gives off the proper interosseous artery, which is named INTEROSSEA COMMUNIS, because both the anterior and posterior arteries are branches of it. Then the ulnar artery is lodged deep under the muscles which go off from the inner condyle, as the palmaris, pronator teres, flexor ulnaris, and flexor digitorum sublimis. But though it passes betwixt the upper and lower flexor, it does not, like the radial, appear immediately as a superficial artery; it shows itself only about three inches above the wrist. The ulnar artery, running along by the tendon of the flexor carpi ulnaris, passes forward from the wrist to the palm of the hand, by the side of the pisiform bone; it then forms the superficial arch of the palmar arteries, and supplies all the fingers, as the radial supplies the thumb.

The arteries which the ulnar gives out after it passes through the muscles, and before it arrives at the wrist, are merely muscular branches, extremely variable in size and number. To enumerate these, would be but to repeat the names of all the muscles which lie upon the flat part of the fore arm.

As the radial sends a branch over the back of the hand, named dorsalis radialis; so does this send a branch round the back of the little finger, named dorsalis ulnaris.

## ARTERIA DORSALIS ULNARIS.

The DORSALIS RAMUS ULNARIS is a small branch which goes off from the ulnar artery as it advances towards the wrist. The ulnar artery goes forwards towards the pisiform bone; while this little artery turns off about two inches below, passes under the tendon of the flexor ulnaris, and round the head of the ulna, to the back of the hand; it then goes upwards along the back of the little finger, where it ends. It gives branches as it passes along to the pronator quadratus, to the extensor ulnaris, to the joints about the lower part of the wrist, and especially to the joining of the radius with the ulna; and it finishes on the back of the hand by arteries given to the tendons and capsule, by inosculations with the rete which is formed upon the back of the wrist, by the radial artery, and by giving the dorsal artery of the little finger.

Next, the ulnar artery, before it begins its arch, gives small branches to the flexor tendons and fore part of the wrist; others to the pisiform bone, to the annular ligament, and to the palmaris cutaneus; and then branches to the flexor, abductor, and adductor of the little finger; or, in other words, to all that mass of muscular flesh which surrounds the root of the little finger; and still, before it begins to bend into an arch, and just beyond the pisiform bone, it gives off that branch which may be called ARTERIA PALMARIS PROFUNDA.

### ARTERIA PALMARIS PROFUNDA.

The description of this artery is shortly this: It is but a small artery; it comes off a little lower than the pisiform bone; it often gives the last lateral artery of the little finger; it then turns downwards and backwards with a large circle, passes through betwixt the two heads of the flexor digiti minimi; by this it gets into the deepest part of the palm, and there joins itself with that palmar branch of the radial artery which comes off at the root of the thumb; and by this inosculation the deep palmar arch is completed.

The ulnar artery having now arrived at the root of the metacarpal bones, but above the tendons of the fingers, forms a great arterial arch across the palm of the hand, which is named the SUPERFICIAL PALMAR ARCH; and this arch gives out the arteries for the fingers after the following order: it does not give off two arteries to each finger, one for each side, because it does not lie at the root of the fingers; but instead of this it sends out three single arteries; each of these goes to the cleft betwixt two of the fingers; and when arrived at the roots of the fingers, these branches divide uniformly and regularly into two branches; of which one goes up along the side of one finger, while the other goes up the opposite side of the next finger; and thus all the fingers are supplied each with two arteries, one running along either edge of each finger. To number them according to the fingers, one, two, three, were mere drudgery and waste of time; and to name and describe them were an absolute abuse, since they are so uniform in all points: it is sufficient to observe, that a long and slender artery runs along each edge of each finger; that generally at each joint or division of the finger the two arteries make arches to meet each other across the hollow where the tendons lie, supplying the tendons and ligaments at the same time; and that the fork of each digital artery receives a branch from the deeper

arch of the palm. That the arteries are each accompanied with corresponding nerves, one for each side of each finger; for the ulnar nerve accompanies the ulnar artery down the fore-arm, and branches along with it in the palm into the form of an arch, with three branches; which three branches are afterwards divided like the arteries, each into two twigs at the roots of the fingers.

The superficial palmar arch finishes with a small branch, which makes another inosculation at the root of the thumb with that superficial palmar branch which comes off from the artery of the thumb, near the place where the artery of the fore finger also comes off.

ARTERIA ULNARIS.

1. *Ramus ad Musculum Pronatorem Teretem.*
2. *Arteria Recurrens Anterior.*
3. *Arteria Recurrens Posterior.*
4. *Arteria Interossea.*
5. *Arteria Dorsalis Ulnaris.*
6. *Ramus ad Musculos Minimi Digiti.*
7. *Arteria Palmaris Profunda.*
8. *Arcus Superficialis Palmaris.*
    1. *Ulnaris Minimi Digiti.*
    2. *Digitales Tres.*
    3. *Ramus Anastomoticus.*

## ARTERIA INTEROSSEA.

The INTEROSSEOUS ARTERY is, after the radial and ulnar, the last of the arteries of the fore-arm. It is but a branch of the ulnar; it arises from the ulnar just where it lies in the very deepest part of the arm, and touches the interosseous ligament. This artery is named INTEROSSEA COMMUNIS, because of two lesser interosseous arteries into which it divides. First, the interossea communis divides about an inch below the elbow into the interossea anterior and interossea posterior; next, the interossea posterior gives off the posterior or interosseus recurrent. That artery is already described; and I proceed to describe now the course of the two interosseous arteries.

First, the anterior interosseous artery is the continued trunk, for it goes straight forwards, and is larger; while the posterior interosseous is smaller, turns out of the straight course to perforate the membrane, and is exhausted before it reaches the wrist.

The anterior interosseous artery lies flat upon the fore part of the interosseous membrane; is larger than a crow-quill, or about half the diameter of the radial artery. As it goes down the fore arm, it gives branches to all the muscles; it gives the nutritious arteries to the radius and ulna; it goes forwards; and, ending in small branches under the annular ligament of the wrist, it makes beautiful net-works and anastomoses over the capsular joints of the carpus.

Secondly, the posterior interosseous artery turns through the interosseous ligament about two inches below the elbow-joint. It instantly gives off the interosseous recurrent; which being very large, the artery seems to be divided into two equal branches, of which one is the recurrent, turning upwards towards the elbow-joint; the other is the posterior interosseous itself, running downwards, and distributing its branches among all the great bellies of the extensor muscles which lie on the outside of the fore-arm.

Thirdly, there is something like a second interossea posterior; for the anterior interosseous artery sends off, about four inches above the wrist, another artery, but much smaller, which perforates the interosseous membrane: might be called a second posterior interosseus; though it is rather to be reckoned among those smaller twigs which, coming off from the anterior interosseus, and perforating the ligament, go through it to the extensor muscles, and are named PERFORATING ARTERIES, being from about four to seven in number.

ARTERIA INTEROSSEA COMMUNIS.
1. *Ramus Muscularis.*
2. *Arteria Perforans Superior.*
3. *Ramus Muscularis.*
4. *Arteria Perforans Inferior.*
5. *Arteria Carpi Anterior.*

# OF THE ARTERIES OF THE THORAX, ABDOMEN, AND PELVIS.

## ARTERIES OF THE THORAX.

### AORTA THORACICA.

The aorta from the arch (after the subclavians and carotids go off) bends downwards and backwards, and touches the left side of the spine. The two membranes called pleuræ, of the right and left side, meet in the middle to form the mediastinum; but as they do not meet immediately, they leave a triangular space, the basis of which triangle is the spine: the sides are the two membranes or pleuræ, inclining towards each other; and there, in the interstice betwixt them, the aorta is lodged, and along with it lies the œsophagus, which runs downwards towards the stomach. The thoracic duct, which is passing upwards to the subclavian vein, and the vena azygos, which returns the blood of the thorax, and brings it into the descending cava; these parts are all involved in cellular substance, and inclosed in this triangular space betwixt the two membranes.

The aorta, as it goes thus downwards beside the spine, gives the following branches: First, as it lies immediately behind the root of the lungs, it gives small arteries which nourish the proper substance of the lungs, the BRONCHIAL ARTERIES: Secondly, as it lies by the side of the œsophagus, it supplies it with small twigs, the ŒSOPHAGEAL ARTERIES: Thirdly, the aorta, as it moves downwards through the thorax, gives off a small and regular artery to the interstice of b as it passes it; and these are the INTERCOSTAL ARTERIES.

The BRONCHIAL arteries are always three, and sometimes four, in number. Their office is not to contribute to the oxydation of the blood; that office

belongs peculiarly to the pulmonic artery; while the small bronchial arteries are for nourishing the proper substance of the lungs; for which end they attach themselves immediately to the trachea, and follow its branches, twisting round them through all the substance of the lungs.

### 1. ARTERIA BRONCHIALIS COMMUNIS.

The COMMON BRONCHIAL ARTERY, so named because it gives branches to both sides of the lungs, arises highest from the fore part of the aorta; it gives two branches, one to the right side of the lungs, and one to the left; the right branch gives an artery to the œsophagus, and sometimes the whole of the right branch goes to that part.

### 2. ARTERIA BRONCHIALIS DEXTRA.

The RIGHT BRONCHIAL ARTERY sometimes like the common bronchial, comes off from the aorta; but very often it comes off from the upper intercostal artery. It goes round the right branch of the trachea, and belongs to that side of the lungs alone: but it gives, notwithstanding, some branches to other parts, especially to the œsophagus, to the back of the pericardium, and to the posterior mediastinum, or membrane which strides across the aorta.

### 3. ARTERIA BRONCHIALIS SINISTRA.

The LEFT BRONCHIAL ARTERY comes off along with the bronchialis communis from the fore part of the aorta; it goes to the left side of the lungs, and also affords small branches to the œsophagus and neighbouring parts.

### 4. ARTERIA BRONCHIALIS INFERIOR.

Often there is a fourth bronchial artery, which we would call BRONCHIALIS INFERIOR, or the LOWER BRONCHIAL ARTERY, because it comes off lower than these, commonly about the place of the fifth rib. It goes to the back of the heart, where the pulmonic vein of

the left side expands into the auricle, and taking the pulmonic vein as a conductor, creeps backwards along it into the substance of the lungs.

These bronchial arteries are the least regular in all the body, coming off usually from the aorta, but sometimes from the mammary, and often from the upper intercostal artery; sometimes also they arise from the intercostals of the aorta. But from one or other of these sources we usually have three or four bronchial arteries, which are so named from their belonging to the branches of the trachea or bronchiæ.

Ruysch, who first discovered this artery, and Sylvius de la Boe and others, who followed Ruysch and used his words in describing the artery, explained its office truly: they said it was for nourishing the substance of the lungs. But this sensible opinion was disputed by many physicians of very great reputation; who maintained that it was quite disproportioned to the size of the lungs, and that it nourished the trachea only; and they gave a most whimsical reason for believing all this. The lungs they consider as made of very coarse stuff, which the half elaborated blood of the right ventricle and pulmonic artery might serve; while the harder and more perfect substance of the trachea required a more perfect and finer blood.

### 5. ARTERIÆ ŒSOPHAGEÆ.

The ŒSOPHAGEAL ARTERIES are generally five or six in number. They are small twigs which come off from the aorta below the bronchial arteries; they encircle the œsophagus, and make anastomoses with each other; and very generally they pass off from the œsophagus to the posterior mediastinum, or that double membrane under the interstice of which the aorta lies. These secondary arteries, along with very small twigs which come off from the aorta itself, some anatomists choose to describe apart under the title of posterior mediastinal arteries.

### 6. INTERCOSTALES INFERIORES.

The LOWER INTERCOSTAL ARTERIES are nine or ten in number, according to the number of ribs which are not supplied by the upper intercostal artery, (for the upper intercostal, which comes downwards from the subclavian artery, supplies usually the intercostal spaces of the two first ribs, but sometimes of three, and sometimes of one only.) The aorta, in its course down the back, gives out, as it passes each vertebra, one artery for each rib; as it goes down along the loins it still gives off an artery at the interval of each vertebra; in the thorax they are named INTERCOSTAL, and in the loins the LUMBAR arteries.

The right intercostals are longer, because they have to mount over the ridge of the vertebræ; the left ones are shorter, because the aorta lies on that side of the spine: the intercostals often give small twigs to the œsophagus and mediastinum; but besides these, each intercostal artery gives three principal branches.

1. By the head of each rib it gives a small artery, which belongs entirely to the spine, and this artery sends one twig to the substance of each vertebra; another twig goes to the sheath or dura mater of the spinal marrow; the third, following each intercostal nerve backwards, enters into the substance of the spinal marrow itself.

2. Each intercostal gives next a larger artery, which perforates near the head of each rib, and passes through to the back, and supplies the longissimus dorsi, latissimus dorsi, sacro-lumbalis, and all the great muscles of the back, which have indeed no other source whence they can derive arteries; and though these are apparently small for so great a mass of muscular flesh, the smallness of the branches is compensated for by their frequency.

3. The intercostal artery proceeds, after giving these branches, along its proper intercostal space,

where it gives an immense number of small arteries to the intercostal muscles; and as each artery passes round the thorax along the ribs, it splits into two branches; one attaches itself to the lower edge of the rib above it, where there is a sort of groove to receive it, *i. e.* the larger artery, and the artery which is to be feared in wounds or operations; the other attaches itself to the upper sharp edge of the lower rib, where there is no groove; this of course is the smaller branch, much less important in all respects. These two, accompanying each rib, run round the circle of the thorax to its fore part, and inosculate with the mammary and epigastric arteries.

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|---|---|
| AORTA THORACICA DESCENDENS. | 1. *Arteriæ Pericardiacæ.* |
| | 2. *Arteria Bronchialis Dextra.* |
| | 3. *Arteria Bronchialis Sinistra.* |
| | 4. *Arteriæ Œsophageæ.* |
| | 5. *Arteriæ Intercostales Aorticæ.* |
| | 6. *Rami Irregulares.* |

## ARTERIES OF THE ABDOMEN.

### AORTA ABDOMINALIS.

The aorta descends into the belly under that arch which is formed by the legs of the diaphragm. It passes along the left side of the spine; but now upon emerging into the abdomen, it inclines nearer to the middle of that ridge which is formed by the vertebræ. The flat and tendinous legs of the diaphragm not only stride over the aorta, so as to form an arch, apparently for its protection, but the uppermost part of the crura turns flat under it, so as to embrace it. No vein goes along with the aorta; for the cava, which returns all its blood, leaves it a little above the pelvis, and inclines towards the right side, that it may enter into the right side of the heart, which it does by passing under the liver.

But the aorta has other very important connections; for as one of its first arteries is the great artery

of the intestines, of course the root of the mesentery (the membrane which conducts the arteries of the intestines) lies over the aorta; and as the mesentery conducts the lacteals from the intestines, of course the meeting of the lacteals and of the lymphatics, or, in other words, the beginning of the thoracic duct, is at the side of the aorta. Again as the great nerves which come down from the breast into the abdomen are destined chiefly for the viscera, they have no other way of reaching the viscera than by taking the direction of the several branches which the abdominal aorta gives out. There are three great branches: the cœliac, the superior mesenteric, and the inferior mesenteric arteries. Of course there are three great plexuses of nerves; the cœliac plexus, the superior mesenteric plexus, and the inferior mesenteric plexus. As these net-works all come from the greater net-work which covers the aorta itself, that plexus is named, from its great size and from its many radiated nerves, the solar plexus; and the semilunar form of the two great nerves which supply the whole gives them the name of semilunar ganglions.

These connections of the aorta, deduced in this general way, will be easily understood; will show the importance of studying this point, where there are so many intricate parts; and will explain also the necessity of mentioning this group of difficult parts at once.

The aorta then passes from the thorax into the abdomen, through betwixt the legs of the diaphragm; the beginning of the thoracic duct lies a little below this point, and the duct itself runs up by the side of the aorta.

The aorta, having come out into the abdomen, the first branch which it gives off is a small one to the diaphragm as it passes under it. The next branch which it gives off is the most important of all, viz. the cœliac artery; and it supplies the stomach, the liver, and the spleen, because they lie in the upper part of the abdomen. Next it gives a great artery to

the intestines, which is named the superior mesenteric artery; for it goes to the intestines which lie within the abdomen. Then it gives the arteries to the kidnies and the spermatic vessels. And, lastly, it gives off a great artery, which is named lower mesenteric; because it supplies chiefly the lower part of the great intestines, and most especially the rectum, where it goes down into the pelvis.

Then the aorta divides into the two iliac arteries, and of course has no longer the name of abdominal aorta.

### ARTERIÆ PHRENICÆ.

The diaphragm has in nine of ten bodies two arteries named the PHRENIC ARTERIES; one going to the right side, the other to the left. The varieties of this artery are too great almost to be mentioned; but, however, these are the chief: generally the phrenic arteries are two small arteries arising from the aorta, one going to the right side, another to the left; often there is one artery going off from the fore part of the aorta, and dividing immediately into two arteries, right and left; sometimes one arises from the aorta itself, another from the cœliac artery; sometimes the cœliac artery, which has properly but three branches, has a fourth added, which is the phrenic artery: sometimes there are three phrenic arteries; sometimes even four; and the diaphragm, it is always to be remembered, receives often smaller branches from the intercostal and lumbar arteries, or from the capsular arteries, besides those which it gets from the thorax accompanying its nerves and coming along the pericardium.

These varieties being mentioned, the history of the regular phrenic arteries may be very short. One goes round the right side of the diaphragm, and the other round the left, with very little variety. First, the phrenic artery crosses what is called the fleshy part of the crus diaphragmatis of its own side, and goes bending along to what is called the ala or wing of the

diaphragm, and gives a great many arteries in all directions into these fleshy sides of the diaphragm ; the artery then turns round, and encircles the great central tendon, where the two phrenic arteries begin to turn round ; they give one branch particularly large to the fleshy sides of the diaphragm, which arise from the ribs ; then bending round the central tendon, they spread all their remaining branches forwards upon the central tendon, and upon that part of the muscle which arises from the sternum, and meet in large inosculations with each other. One branch often pierces the diaphragm, goes into the pericardium where it is attached to the diaphragm, and unites with that artery which comes down along with the phrenic nerve, the comes nervi phrenici.

But still it is to be remembered, that the phrenic arteries, before they enter into the diaphragm, give small arteries to the capsulæ renales, and to the œsophagus and neighbouring parts; the œsophageal branch running upwards into the thorax, to inosculate with the upper arteries of the œsophagus.

## OF THE ARTERIES OF THE STOMACH, LIVER, AND SPLEEN.

The upper part of the abdomen is occupied entirely by the stomach, liver, and spleen ; the stomach in the middle, the liver on the right hand, and the spleen on the left. The cœliac artery supplies all these parts ; it rises up from the fore part of the aorta a short thick artery encircled by the lesser arch of the stomach ; and immediately splits into three branches, of which the middle branch goes to the stomach, the left goes to the spleen, the right goes to the liver ; and thus we have all the branches of the cœliac artery neatly and simply arranged.

### ARTERIA CŒLIACA.

The CŒLIAC ARTERY is so important, that its place and connections must be more minutely described.

It arises from the fore part of the aorta, just at that place where the aorta is closely embraced by the crura diaphragmatis, and over the eleventh vertebra of the back; it juts directly forwards, almost at right angles from the aorta, and is encircled by the lesser arch of the stomach; the artery standing up betwixt it and the diaphragm. The cœliac trunk, then, is so placed as to be surrounded by these parts; it has the œsophagus on the left hand; the lobulus Spigelii, or lobulus papillaris of the liver, on the right hand; it has the lesser arch of the stomach making its turn under it; and it has the diaphragm above and the pancreas running across below; it is covered by the delicate web of the omentum, named omentum minus, which goes from the lesser arch of the stomach to the liver and to the spine.

Now this short jutting out or stump we call the trunk of the cœliac artery; or we call it axis arteriæ cœliacæ, for there is no other artery of the body that divides like it: the stump, which is less than half an inch in length, serving as an axis, from which the three great branches, viz. to the stomach, liver, and spleen, go off all at once, in a tripod-like form; one upwards, one to the right, and one to the left. The hepatic, which goes to the right, is largest in the child, because of the great bulk of its liver; the splenic, which goes to the left, is larger in the adult; the gastric is almost always the smallest of the three.

### 1. ARTERIA CORONARIA VENTRICULI.

The CORONARY ARTERY of the STOMACH is the central artery of the tripod. When it belongs entirely to the stomach, it is smaller than the splenic or hepatic arteries: but when it gives (as often it does) a branch to the liver, it is the largest of the three. This gastric artery, or coronary artery of the stomach, is generally the smallest, not very much larger than a crow-quill; it rises upwards, and turns a little towards the left side, because the cardiac orifice of the stomach is there.

Before it reaches the cardiac orifice of the stomach, it divides itself into two great branches; one going round the cardiac orifice of the stomach, and the other returning along the lesser arch.

CORONARIA SUPERIOR VENTRICULI.

The branch which belongs to the cardiac orifice of the stomach attaches itself to the œsophagus, just where it emerges from the diaphragm, and is joined to the stomach: the artery turns round the œsophagus, passes first under and behind it, and then turns round and appears on the fore part, or rather on the left side, of the stomach to spread over it. In the middle of this turn it gives off an artery which runs backwards along the œsophagus, takes directly the line of the œsophagus, runs up with it into the thorax a considerable way, inosculates with the upper œsophageal arteries, and though a small branch, it is long, and seldom wanting. The second branch is a continuation of the same artery encircling the cardiac orifice, sending its arteries down over the large and bulging part of the stomach, somewhat in the form of a crown. As the spleen is attached to this end of the stomach, this artery inosculates with what are called the vasa brevia, or short vessels coming from the artery of the spleen; and so it ends, having the name of CORONARIA SUPERIOR VENTRICULI.

The second branch of the coronary returns along the lesser arch of the stomach; it is so connected with the last that it may be called ramus coronariæ dexter, though properly it is not a branch, but the continued trunk of the gastric artery. As the first branch turns round behind the œsophagus, this stops and turns to the lesser arch of the stomach, touches it just at the cardiac orifice, *i. e.* at the root of the œsophagus; turns with a gentle turn round the lesser arch of the stomach, bending as the arch bends, giving its branches down both forwards and backwards over each side of the stomach. As it runs along the stomach it is sensibly exhausted by these arteries, so

that it arrives very small at the lower or pyloric orifice of the stomach; there it turns over from the stomach upon the small gut in such a way as to belong to the pylorus or union of the gut with the stomach; and though small and trivial, it has an appropriated name, ARTERIA PYLORICA SUPERIOR, and thus the gastric artery ends.

But sometimes, as has been mentioned in the general description, this gastric artery sends a branch to the liver; yet, in that case the order of these arteries already enumerated is in no degree disturbed; the artery running along the œsophagus, the artery running round the cardia and in form of a crown, the artery returning along the lesser arch, are still the same; only, after giving off this last artery, the trunk of the gastric goes off from the stomach, continues its course towards the liver, and passes into it.

### 2. ARTERIA HEPATICA.

The HEPATIC ARTERY goes off from the cœliac axis, where it almost touches the point of the Spigelian lobe. The pancreas covers the root of the hepatic artery; it then turns a little forwards, and rising somewhat upwards at the same time, it passes under the pylorus, *i. e.* under the stomach and duodenum; it passes behind the omentum minus and biliary ducts; it arrives at the porta where the great vena portæ enters the liver, and where the great biliary ducts come out; it passes the vein, and to the left of the biliary ducts; and having a little before divided into two great branches, these now enter into the right and left lobes of the liver. In this place it is inclosed along with all the other vessels in that sheath of cellular substance which is called the capsule of Glisson.

Thus the artery finally terminates near the liver in two great branches, right and left; but before it does so, it gives, as it passes the stomach, duodenum, and pancreas, very important branches to these parts. Before it gives these more important branches, it

gives small twigs to the vena portæ and to the head of the pancreas; then it gives off the great artery which is the source of these lesser arteries, (to the pylorus, pancreas, and duodenum,) viz. the ARTERIA DUODENO-GASTRICA, which, soon after it goes off from the hepatic artery, divides into two chief branches. One turns backwards along the duodenum to the stomach, and from supplying the stomach and epiploon, is named GASTRO-EPIPLOIC ARTERY. The other, turning downwards along the duodenum, gives at the same time arteries to the pancreas, and so is named ARTERIA PANCREATICO-DUODENALIS. The trunk which divides into these two arteries may be described thus: The duodenum begins from the pylorus; the pancreas pours its liquor into the duodenum; and therefore the head of the pancreas is attached to the duodenum: this marks the point at which the trunk of the ARTERIA DUODENO-GASTRICA goes off; for it rises at right angles from the hepatic; it lies behind the lower end of the stomach, just between the pylorus and pancreas; there it splits into its two great branches, viz. to the duodenum and to the stomach. But besides these two great branches there are subordinate arteries, which must be enumerated together with them.

One artery goes off to the upper and back part of the duodenum over the biliary ducts; next go off small arteries to the duodenum of still less importance, and nameless; and at the same place small twigs are often given to the pancreas.

The first which is distinguished or regular, or has a name, is the PYLORICA INFERIOR, the lower pyloric artery. It goes off from the PANCREATICO-DUODENALIS almost as soon as it touches the duodenum; there are sometimes two or more pyloric arteries going off at this point; they encircle the pylorus with delicate branches; and at the same time turn obliquely upwards, to receive inosculations from the upper pyloric, which comes from the artery of the stomach.

The next artery to be distinguished by a peculiar

name is one which goes off directly opposite to this, belongs to the pancreas, and is named from its running transversely across the pancreas, the TRANSVERSE PANCREATIC ARTERY. It is a neat small branch, which passes under the pancreas, runs along its back part, gives its arteries into the substance of the pancreas from side to side; and yet is not exhausted till it has run along more than two-thirds of the length of this long gland.

The next branch is that from which the whole artery has its name: for the artery having given off the lower pyloric artery, and the transverse artery of the duodenum, turns downwards, bending according to the circle which the duodenum makes, lying in the hollow side of that circle just as other mesenteric arteries lie along their proper intestines. In all this circle it gives continual arteries outwards to the duodenum: it gives also frequent arteries inwards to the pancreas. From these two connections this branch is peculiarly named ARTERIA PANCREATICO-DUODENALIS. It ends in inosculation with the mesenteric artery.

At the place where this pancreatico-duodenalis turns downwards, the other great branch turns backwards and upwards to reach the stomach. It is so great that it must be considered as the continuation and ultimate part of the artery. It goes to the stomach and epiploon, and thence is named gastro-epiploic artery.

The course of the gastro-epiploic artery is along the lower part of the stomach, and is most beautiful; it makes a broad sweep round all the greater arch of the stomach; it lies in that line where the great omentum comes off from the stomach; it sends many and large branches upwards upon the stomach, both on its fore and on its back surfaces; it sends opposite branches, very frequent and considerable, down into the web of the omentum or epiploon; it runs along the stomach till it meets with a similar branch from the splenic artery; and the inosculation between

them is so large and perfect, that we cannot tell where the one artery ends or the other begins. This branch from the hepatic artery is named the right artery of the stomach, or the right GASTRO-EPIPLOIC ARTERY, while that from the splenic artery is the left.

Besides this great artery to the duodenum and stomach, the hepatic artery, before it plunges into the liver, gives another branch, but small; it is named pylorica superior hepatica.

### PYLORICA SUPERIOR HEPATICA.

The PYLORICA SUPERIOR HEPATICA is so named to distinguish it from that upper pyloric artery which comes down from the stomach, and sometimes it is called GASTRICA vel CORONARIA MINOR. It comes off from the hepatic artery just before it divides, or immediately after from the left hepatic. It turns backwards at an acute angle to the lesser arch of the stomach, and, having given small twigs to the omentum minus, it goes directly to the pylorus, inosculating with its upper and lower arteries.

### HEPATICA SINISTRA.

The hepatic artery, now advanced to within about two inches of the liver, divides into its two great arteries. Both go to the porta of the liver; but the one belongs to the right lobe, the other belongs to the left. The artery which belongs to the left lobe of the liver is smaller, and when there is a hepatic artery from the stomach it is very small; it mounts over the vena portæ, and enters into the liver at the fossa umbilicalis; its branches within the liver go chiefly to the left lobe, lobulus Spigelii, and anonymous lobe.

### HEPATICA DEXTRA.

The right branch of the hepatic artery passes under the biliary ducts, enters along with them into the right lobe of the liver, and before it does so it gives off the arteria cystica, or artery of the gall-bladder,

one of the most beautiful little arteries in the body. The cystic artery branches over the gall-bladder, betwixt its coats, in the form of a coronary artery, and having made a beautiful tree of branches over the gall-bladder, it passes off from it, and goes to the substance of the liver.

## ARTERIA SPLENICA.

The SPLENIC ARTERY is one of the most remarkable in the human body. The spleen is tied down to the left side of the diaphragm by a proper ligament; it is also connected with the greater or bulging end of the stomach by processes of the omentum and by vessels. The splenic artery, the largest branch of the cœliac, as large as a goose-quill, turns off from the cœliac trunk almost at right angles, and runs across the abdomen to get to the spleen. It is in all this course exceedingly tortuous; it runs along the upper edge of the pancreas, (which also lies across the abdomen,) and gives arteries to it; when it approaches the spleen, it gives off that great artery which returns along the lower border of the stomach, and when it actually arrives at the spleen, it divides into a great many branches, which enter by the concave surface of the spleen, and plunge into its substance.

The branches, then, of the splenic artery, are these: 1. It gives a great artery to the pancreas, named PANCREATICA MAGNA, which passes to the right under the pancreas, and belongs chiefly to the head of the pancreas, or that rounded end which is next to the duodenum. Though named magna, it is a variable artery, and of little importance. 2. All along, as the splenic artery is passing to the left by the border of the pancreas, it sends short branches into it. They are named PANCREATICÆ PARVÆ, or small PANCREATIC ARTERIES. 3. It often sends small arteries upwards to the back part of the stomach, named POSTERIOR GASTRIC ARTERIES. 4. The GASTRO-EPIPLOICA SINISTRA, or the left gastro-epiploic artery,

is a very large and principal branch of the splenic artery. It arises under the stomach, a little beyond the left or larger head of the pancreas; it makes a large arch, and then turns with a serpentine turn towards the stomach, returns along the lower border of the stomach, within the doubling of the omentum, and gives its arteries upwards to the stomach and downwards upon the omentum, so much like those of the right gastro-epiploic artery, that when they meet in the middle of the great arch of the stomach, and inosculate, we cannot distinguish where either of them ends; the chief difference is, that some of the epiploic branches of this artery are particularly large. 5. The VASA BREVIA are a set of three or four arteries which the splenic gives off just before it enters the spleen; and as the artery lies close to the stomach, these arteries which go to the great bulging of the stomach are exceedingly short, and are thence named vasa brevia. The artery ends by eight or ten branches, which plunge into the spleen. Sometimes we see the artery pass, almost undivided, or divided into one or two branches only, into the bosom or sinus of the spleen.

These are all the arteries of the stomach, liver, and spleen, the viscera which fill the upper region of the abdomen.

RECAPITULATION OF THE BRANCHES OF THE

ARTERIA CŒLIACA.

- 1. *Arteria Coronaria Ventriculi.*
  - 1. *Ramus to the Stomach.*
  - 2. *Ramus ascending to the Œsophagus.*
  - 3. *Ramus to the Diaphragm and Omentum Minus.*
  - 4. *Ramus to the lesser Curvature of the Stomach.*
  - 5. *Arteria Pylorica Superior.*
- 2. *Arteria Hepatica.*
  - 1. *Arteria Hepatica Dextra—Arteria Cystica.*
  - 2. *Arteria Hepatica Sinistra.*
    - 1. *Coronaria Dextra.*
    - 2. *Duodeno Gastrica.*
      - 1. *Pylorica Inferior.*
      - 2. *Pancreatica Duodenalis.*
      - 3. *Gastro-Epiploica.*
- 3. *Arteria Splenica.*
  - 1. *Pancreaticæ.*
  - 2. *Vasa brevia.*
  - 3. *Arteria Gastro-epiploica Sinistra.*

# OF THE ARTERIES OF THE INTESTINES.

## OF THE UPPER AND LOWER MESENTERIC ARTERIES.

The bowels are so disposed within the abdomen, that the largest of them, viz. the colon, the great intestine, encircles all the others. It begins on the right side in a blind sac called the caput coli, or head of the colon: it goes upwards, and crosses the belly, so as to support the stomach, and separate the stomach, liver, and spleen, from the small intestines: it descends again into the pelvis at the left side, forming the rectum; and all the small intestines hang by their mesentery in the central part of the abdomen, surrounded by this great intestine; and the arteries lie within the two lamellæ of the mesentery or supporting membrane of the intestines, so that they are called mesenteric arteries; and they follow the intestines in the order in which I have named them.

The GREAT OF SUPERIOR MESENTERIC ARTERY gives its first branches to the caput coli; its next branch to the middle of the colon under the stomach; the thousand turns of the small intestines next absorb all its other branches. The LOWER MESENTERIC ARTERY, which gives no branches to the small intestines, attaches itself to the left side, and especially to the lowest part of the colon, and goes down with the rectum into the pelvis, and ends there. This, then, may serve as a general plan or arrangement for the intestines and for the two mesenteric arteries.

### 1. MESENTERICA SUPERIOR.

It is not surprising that the UPPER MESENTERIC is the largest of all the abdominal arteries. It arises from the aorta, where it is still betwixt the legs of the diaphragm, and not more than half an inch below the cœliac artery. The cœliac and mesenteric arteries lie close upon each other; only we are less sen-

sible of their nearness by the axis cœliacæ jutting perpendicularly forwards, and by the trunk of the mesenteric running very obliquely downwards, and by the head of the pancreas lying immediately over the mesenteric and hiding its root. The trunk of the mesenteric artery passes under the pancreas, then through the mesocolon or mesentery of the colon, then into the proper mesentery of the small intestines. It turns first to the left; and then, by a second gentle bending, it turns again towards the right side of the abdomen. It runs very low into the abdomen before it gives out any branches; and then it gives them off in the following order.

From the right side it gives branches to the great intestines, of which there are three chief arteries; but from the left side, where it gives arteries to the small intestines, it gives innumerable branches, very large, and so inosculated with each other, that they form a sort of mesh or immense plexus in the mesentery before they go onwards to the guts. The undivided trunk of the artery is very large and long; the gentle curvature of it from left to right, gives it the form of an Italic *ſ*; the prodigious size of that mesh or plexus of vessels which goes to the great intestines is such as to carry the artery down to the left ilium or flank, where the caput coli or conjunction of the ilium with the colon lies.

It is from the convex of this gently bending arch, and from the right or outer side of the artery, that the following arteries to the great intestines go off.* The COLICA MEDIA to the middle of the great intestine, the COLICA DEXTRA to the right side of the great intestine, the ILEO-COLICA to the joining of the ilium with the caput coli or beginning of the great intestine.

* Often before giving off its greater arteries, the mesenteric gives to the pancreas several small arteries; and to the duodenum two or three, which are sometimes named under the title of duodenales inferiores.

### COLICA MEDIA.

1. The MIDDLE COLIC ARTERY passes along in the doubling, *i. e.* betwixt the two lamellæ of the meso-colon. It goes with a circular sweep upwards towards that part or corner (as we may call it) of the colon which lurks under the liver; but before it touches the intestine, and generally at the distance of about three or four inches from it, this artery divides into two great branches; one turning backwards, along the right side of the colon, inosculates with the colic arteries; the other, more like the continued trunk, turns upwards, bending according to the curvature of the arch of the colon, which supports the stomach; and having rounded the concave of this arch, and arrived at the left side, it there makes a great inosculation with the left colic artery, which is a chief branch of the lower mesenteric; and so completes the great mesenteric arch, one of the most celebrated inosculations in the whole body, that of the circle of Willis hardly excepted.

### COLICA DEXTRA.

2. The RIGHT COLIC ARTERY is enumerated as a distinct artery chiefly for the sake of plainness; for though sometimes it arises apart from the general mesenteric trunk, yet in ninety-nine of one hundred bodies it proceeds from the upper or middle colic artery. It is a very large branch; it is set off from the colica media at a very acute angle; it moves along the right side of the colon, inclining also a little upwards towards the liver; it also splits when it approaches the gut into two branches; one turning towards the upper side to inosculate with the middle colic artery, the other turning downwards towards the ilium or flank to inosculate with the ileo-colic artery.

### ARTERIA ILEO-COLICA.

3. The ILEO-COLIC ARTERY arises about an inch lower than the last. It is a long, small, and slender

artery, compared with the two last; which are short, stumpy, and with contorted angles. This artery goes to the place where the small intestines end, and the great ones begin; of course, the membrane which holds the intestines at this corner (I mean in the right haunch) changes its name from MESO-COLON (in the middle of the colon) to mesentery, or MESO-ENTERON (in the middle of the intestines); and of course the ileo-colic artery runs down, not along the mesocolon, but along the mesentery. It goes directly down towards the joining of the ilium with the colon; it ends in three regular branches; one passes straight onwards to the junction of the ilium and colon, splits into two branches, one going over the fore and the other over the back part of the caput coli, and having a very curious correspondence with the valve within, so that it might be called ARTERIA VALVULÆ COLI. While this branch goes straight forwards over both sides of the caput coli, another branch runs backwards along the colon, and inosculates with the right colic artery; and another runs downwards along the ilium, and inosculates with the common branches of the mesenteric artery. It is from these two branches, which diverge like the rest of the colic arteries, that this is called ILEO-COLICA. Even the appendix vermiformis has its little mesentery tying it down to the caput coli, and from the back of the caput coli a little artery runs down upon that mesentery to the appendix, passing along the whole length of that process.

From this point all the remaining arteries of the mesenterica superior go to the small intestines; and they are so undistinguished, and so prodigiously numerous, that no branches can be described or named; there is nothing but a great net-work of arteries to describe. The first or radical branches which go to the small intestines, are thick, large, short, and vary from twelve to fifteen or twenty in number. But it is not these that make this vast appearance of a network; these twelve branches are first joined to each

other, as it were mouth to mouth, forming one great confluence of arterial arches: from these, secondary branches arise, and they unite again in like manner, and make a second row of arches; from the union of these still other arteries arise, and make a third, or fourth, and even a fifth row of arches, before any arteries go to the intestines; till at last the proper arteries of the intestines go out in straight lines from the last arch, and spread upon the coats of the intestine. In short, the mesentery has a very intricate and matted appearance from the redoubling of these arches, which are more and more numerous as the artery proceeds lower. The last of the twelve radical branches makes an arch, which serves the ileon or lowest of the small intestines, and inosculates with the ILEO-COLIC ARTERY.

2. MESENTERICA INFERIOR.

The LOWER MESENTERIC ARTERY is that which is named by Haller the left colic artery, because it goes only to the left side of the colon. It arises from the fore part of the aorta, below the two emulgent arteries, *i. e.* pretty low down. It goes off rather from the left side of the aorta; it goes off very obliquely, and keeps close to the left side of the aorta for a great way; and when it has descended as low as the bifurcation of the aorta, it gives off its great branch to the left side of the colon, viz. the LEFT COLIC ARTERY; and then turning down over the iliac artery of the left side it descends into the pelvis, along with the rectum, and ends there.

1. Its first branch is the ARTERIA COLICA SINISTRA. The lower mesenteric has run a considerable length, has passed as low as the bifurcation of the aorta, before this branch is given off. This artery soon divides into three large branches; the trunk itself is short and stumpy, the branches go off like those of the other side, at very acute angles: First, One branch ascends towards the angle of the colon, under which the spleen lies, and there divides itself into two

branches; one keeping closer to the intestine, nourishes it; the other keeping more to the middle of the meso-colon, or broad membrane of the colon, meets the branch of the upper mesenteric, and completes with it the mesenteric arch, being indeed the larger and more important artery of the two. Secondly, Another branch goes directly across to the right side of the colon, and when it approaches the gut, splits (as usual with the colic arteries) into two lesser branches, one turning upwards and the other downwards. Thirdly, The third branch of this left colic artery goes obliquely downwards to that part of the gut which lies in the hollow of the left haunch-bone, and which forms the turn named sigmoid flexure of the colon; and the membrane of the colon is here so fast braced down to the loins that this artery gives twigs to the loins inosculating with the lumbar arteries.

### ARTERIÆ HÆMORRHOIDALES.

The INTERNAL HÆMORRHOIDAL ARTERY is one of considerable size: it is just the trunk of the lower mesenteric artery, descending into the pelvis; it is often as large as a writing quill; it applies itself closely to the back part of the rectum; it arrives at it by turning obliquely over the pelvis, and under the rectum, and passes down its whole length quite to the anus. It encircles the rectum completely on each side with its large branches, which meet again upon the fore part of the gut, and its branches lower down in the pelvis, inosculate with the middle hæmorrhoidal artery, and sometimes with those of the bladder and womb. This is the artery which prevents us from operating when a fistula in ano has gone deep by the back of the rectum; and which has given occasion to the establishing of something like a general rule in surgery, that one should not operate when the fistula is more than two or three inches deep. It is the last of the arteries belonging to the loose and floating viscera.

## OF THE REMAINING ARTERIES OF THE ABDOMEN, VIZ. TO THE KIDNIES, TESTICLES, &c.

### ARTERIÆ CAPSULARES.

The capsulæ atrabiliares are two small bodies of a triangular form, of thick walls and small cavities, filled in general with a black and bilious-looking liquor. The ancients thought this the atrabilis, and named them the capsulæ artrabiliares: the moderns, from seeing them placed immediately above the kidney, and observing no apparent connection but with that gland, have named them capsulæ renales. They lie, then, above the kidney, are, like the kidney, surrounded with fat, have straggling arteries from various sources, but none regular or important.

First, They have, very generally, some small branches from the phrenic arteries. These are the highest of the capsular arteries; they touch the uppermost point of this glandular body. They are named the upper CAPSULAR ARTERIES. Secondly, They often have small arteries from the aorta peculiar to themselves, which come off about the root of the upper mesenteric artery, go to the fat and glands, and play over the vena cava, (at least those of the right side do,) and go to the middle parts of the gland, whence they are named CAPSULARES MEDIÆ. Thirdly, They have their last arteries sent upwards to them from the emulgent artery, or artery of the kidney. They are named the lower CAPSULAR ARTERIES.

### ARTERIÆ RENALES.

The two RENAL OF EMULGENT ARTERIES, the two arteries of the kidnies, go off from the sides of the aorta, midway betwixt the upper and lower mesenteric arteries. Each goes to its kidney almost at a right angle, arching a little over the bulging belly of the psoas muscle. The aorta is still a little inclined to the left side, and so the left emulgent is shorter, and mounts over its accompanying vein; while the right

kidney, being further off from the aorta, and somewhat lower, on account of the liver being on that side, the right artery is longer, and is covered by its emulgent vein. When the emulgent artery, which is short and very thick, arrives at the concave edge of the kidney, it is divided into three or four large branches, which surround the pelvis, or beginning of the ureter, plunge into the substance of the kidney, and inosculate and make arches with each other. Thus, in supplying the kidney within its substance, they form circles and arches over the roots of the papillæ uriniferæ.

Before the emulgent arteries enter into the substance of the kidney, they usually give off small arteries, as has been already mentioned, to the lower part of the capsulæ renales, to the upper part of the ureters, and to the fat surrounding the kidnies.

### ARTERIA SPERMATICA.

The SPERMATIC ARTERY, or artery of the testicle, is one of the most singular, both for its extreme smallness and great length, and for its important office. It arises on each side from the lateral parts of the aorta, a little above the lower mesenteric artery. The left spermatic artery rises somewhat higher, and often comes from the emulgent artery; it descends from the aorta almost in the same line with itself; it crosses the vena cava, and meets its accompanying vein upon the surface of the psoas muscle; it then forms the spermatic cord, and passes obliquely through the spermatic passage and abdominal ring; before it goes down into the testicle, it gives out many very small twigs. First, It gives small twigs to the fat of the kidnies; secondly, It gives small branches to the ureters; thirdly, Small twigs to the peritonæum; and lastly, Small twigs to nourish the spermatic cord itself. When it has passed through the ring, it soon after divides into many small arteries for the several parts of the testicle, four or five in number; two of which go to the epidydimis, and two others, particu-

larly large, go to the testicle; the largest of these branches turns round the testicle in a beautiful and serpentine form, waving along the upper part of the testicle, viz. just under the epidydimis, and sending beautiful coronary branches downwards all over the semicircle or convex surface of the testis.

These are the chief arteries, viz. those of the kidney and testicle. Those of the renal capsule I hold to be so irregular, that they hardly deserve the short description which I have given of them. The following classes of small and irregular arteries are equally insignificant; for few authors have been at the pains to enumerate the arteries going to the fat of the kidney; and none (except Murray) have been at the pains to gather together into one class or description the trifling arteries of the ureter.

### ARTERIÆ ADIPOSÆ.

The ARTERIES of the FAT of the kidney are extremely small but numerous. The upper arteries come from the capsular and diaphragmatic arteries which are above the kidney; the middle arteries of the fat come from the renal artery itself, from the spermatic, or even from the aorta; the lower arteries come from the colic arteries, and one from the spermatic, which comes off below the kidney, and turns up towards its lower end.

### ARTERIÆ URETERICÆ.

As the ureter is a long canal, its arteries come off from various parts which it passes. Its upper arteries are from the renal artery itself, before it enters the kidney; and also from the capsulars and spermatics. The middle arteries of the ureter are more particular and more important: they arise either from the aorta itself, or from the iliac artery, where the ureter crosses it; and they run far both upwards and downwards, along the canal. The lowest arteries of the ureter arise from those of the bladder itself.

### ARTERIÆ LUMBALES.

The LUMBAR ARTERIES are those which succeed to the intercostal arteries, and which run parallel with them; performing the same office in the loins which the intercostals do in the thorax, viz. nourishing the spine and the muscles.

The lumbar arteries arise from the sides of the abdominal aorta. The first arteries go off at right angles; the lower ones are a little inclined downwards. The right ones are longer, because they have to rise over the spine. The arteries of both sides, as soon as they have left the spine, sink under the psoas muscle, and go onwards behind it, round the side, till they terminate in the lateral muscles of the abdomen. The uppermost lumbar artery is large; and as it runs along the lowest rib but one, it of course gives arteries both to the transverse or innermost muscle of the belly, and also to the diaphragm, which indigitates with it in consequence of their both taking their origin from the same ribs. The two lower lumbar arteries are small, and begin to inosculate with the lesser arteries about the top of the pelvis.

Each lumbar artery gives out, like the intercostals, two chief arteries: 1. One which goes to the spine, and which, splitting into two, gives a larger twig to the vertebra itself; and a smaller one, which enters the sheath, lies by the nerve, and passes into the spinal marrow. 2. A muscular branch, which is also divided; for one branch of it supplies the psoas muscle, and then runs round within the muscles of the abdomen; while the other pierces the back, and supplies the sacro-lumbalis, longissimus dorsi, and other muscles of the loins.

RECAPITULATION AND PLAN OF THE BRANCHES OF THE

| | | |
|---|---|---|
| AORTA ABDOMINALIS. | 1. *Arteria Phrenicæ Dextra.* | |
| | 2. *Arteria Phrenica Sinistra.* | |
| | 3. *Arteria Cœliaca.* | |
| | 4. *Arteria Mesenterica Superior.* | |
| | 5. *Arteria Mesenterica Inferior.* | |
| | 6. *Arteriæ Capsulares.* | |
| | 7. *Arteria Renalis Dextra.* | |
| | 8. *Arteria Renalis Sinistra* | *Arteria Spermatica Sinistra.* |
| | 9. *Arteria Spermatica Dextra.* | |
| | 10. *Arteriæ Lumbales.* | |
| | 11. *Arteria Sacro-Media.* | |
| | 12. *RamiIrregulares—to the ureter, peritonæum, &c.* | |

## ARTERIES OF THE PELVIS.

The aorta divides into two great arteries, named iliac arteries. The two iliac arteries move downwards to the brim of the pelvis, where they meet the veins of the lower extremity ascending to form the cava, and also a vast plexus of lymphatics from the legs and pelvis, which twist round the arteries and veins. The two iliac veins lie upon the inner sides of the two arteries; and since these veins meet on the right side of the aorta to form the cava, of course the right iliac artery crosses the trunk of the cava. This bifurcation of the aorta is much higher than the pelvis; it begins upon the fourth vertebra of the loins, so that the abdominal aorta is short, notwithstanding the great number of its branches, and the iliac arteries go off at such an angle, that they diverge very gradually; so that when they arrive at the top of the pelvis, they are just over the joining of the haunch-bone with the sacrum; and it is but a very little below this again that they divide into their two great branches; the one, named the external iliac, which passes straight forwards into the thigh; the other, the internal iliac, which dives immediately down into the pelvis to supply the internal parts.

### ARTERIA SACRO MEDIA.

The bifurcation of the aorta gives off only one artery, which proceeds exactly from the fork; and being in the middle, it is a single or azygous artery, which has not a fellow. It is small, long, very regular, and passes down so correctly in the middle of the bone, that it is named the MIDDLE SACRAL ARTERY. It is about the size of a crow-quill; passes directly over the middle of that projecting point which is named the promontory of the sacrum; it descends expressly in the middle of the bone, quite to the point of the os coccygis. At the place of each vertebra, (for the sacrum consists of vertebræ now united together,) it gives off cross branches, which go across the body of the sacrum to inosculate with the lateral sacral arteries. Besides these, it gives arteries to the substance of the bone, and not unfrequently small arteries to the rectum. This artery ends near the point of the os coccygis in a forked or double inosculation with the lateral sacral arteries of each side.

### ILIACA INTERNA.

The INTERNAL ILIAC ARTERY is of vast size; it not only supplies all the parts within the pelvis, but sends out by the several openings of the pelvis those great arteries which supply both the private parts, and the immense mass of muscle which surrounds the haunch. Thence the necessity and the usefulness of arranging them under two classes: first, of the lesser arteries which go to parts within the pelvis, as to the loins, to the sacrum, to the bladder, and to the womb; and, secondly, those larger arteries which go out through the several openings of the pelvis, the hips, the haunch, and the private parts.

This artery we cannot describe in the adult, without attending to its condition and function in the child; for it is that indeed which gives it the peculiar form which we have to describe; and which especially gives it that arch downwards, from the

convexity of which all the great branches go off. For in the child, the internal iliac or hypogastric artery is extremely large: first, it turns down into the pelvis with a large circle; then it goes close to the side of the bladder very low into the pelvis; then it begins to rise again by the side of the bladder, out of the pelvis, and going along by the urachus (which is a tube or ligament rather leading upwards from the bottom of the bladder,) it goes out by the navel, forming the umbilical artery. Now this sudden turn by the side of the bladder makes the artery convex downwards, *i. e.* towards the parts which it has to supply. The artery keeps this same form in the adult; both in the child and in the adult all the great branches come off from the back of this arch.

## ORDER FIRST.

### THE BRANCHES OF THE HYPOGASTRIC OR INTERNAL ILIAC ARTERY, WHICH REMAIN WITHIN THE PELVIS.

#### 1. ILEO-LUMBALIS.

This artery is so named, because it so resembles the lumbar arteries that it might be mistaken for the last of them; and because it belongs equally to the haunch-bone and to the loins. It goes off from the outer side of the iliac artery, about an inch below the bifurcation; it is about the size of the lumbar arteries, or a little larger; it turns in behind the iliac artery, and passes under the psoas muscle; its trunk is short, for it splits immediately into its iliac and lumbar branches. The lumbar branch goes off betwixt the last vertebra of the loins and the inner end of the ilium, and goes directly upwards; it gives its branches about the psoas muscle. The iliac branch setting off from the same point, runs straight outwards, lodges itself under the edge or crista ilii, and supplies the iliacus internus muscle by a superficial branch; and it nourishes the bone by a deeper branch, which lies close in the hollow of the haunch.

### 2. ARTERIÆ SACRÆ LATERALES.

The LATERAL ARTERIES of the SACRUM are very generally three or four in number. Sometimes we find one general artery coming off from the iliac, or from the ileo-lumbar artery, running down all the side of the sacrum, and giving off the lateral sacral arteries; but much more frequently we find three distinct arteries coming off from the sides of the iliac artery, which run across the sacrum in the following manner, to inosculate with the middle sacral artery: First, each lateral sacral artery has one large branch, which runs along the fore part of the sacrum, runs along the naked bone, and inosculates with the middle sacral artery: Secondly, another branch, still larger, dives into each of the sacral holes, which not only nourishes the nerves, and the sheath of the cauda equina, and the bone itself by one branch, but penetrates by another branch through the posterior sacral hole, and supplies the periosteum, the great ligaments which join the ilium to the sacrum, and the root also of the sacro-lumbalis, and glutæal muscles. From these two branches, (viz. to the spine and to the posterior muscles,) and from the regularity of these five arteries, (going from some artery or other into each sacral hole,) they resemble the intercostal and lumbar arteries, to whose office and place they have succeeded.

### ARTERIA HYPOGASTRICA.

The HYPOGASTRIC ARTERY, or the umbilical artery, is of great size and importance in the child; and even in the adult it still remains, in this sense at least, that though the fore part of it (where it turns up by the side of the bladder) is closed, even that part is still known by a round ligamentous substance, into which it is converted, and which we easily trace up to the navel, where the artery meets its fellow of the other side.

This artery is even in the adult body pervious

down to the side of the bladder, where in Man it gives one long and slender artery, sometimes two, which go to the sides of the bladder; and in Women, small arteries to the womb, sometimes to the rectum; but these branches are quite irregular in number and size.

### ARTERIÆ VESICALES.

The ARTERIES of the BLADDER are extremely irregular both in number and size; for it is to be considered, that the bladder being a round body placed amidst great arteries, and being itself membranous, and needing but few or but small branches, it gets them from various sources. Very generally the hypogastric, just before it closes into a ligament, sends one or more small arteries downwards and forwards to the neck of the bladder, at that part where the vesiculæ seminales lie; and of course the vesiculæ and the prostate gland get small twigs from this artery of the bladder; sometimes also the bulb of the urethra has a small artery from it.

### ARTERIÆ HÆMORRHOIDALES.

The arteries of the rectum are all named hæmorrhoidal arteries. The upper hæmorrhoidal artery is the great branch of the lower mesenteric continued to the pelvis. The middle hæmorrhoidal artery is one which sometimes comes from the hypogastric artery, but very often from the pudic artery, insomuch as to be reckoned among its regular branches. The lower, or the external hæmorrhoidal artery, almost always is a branch of the pudic artery, or that artery which goes to the penis. Two great arteries, one going to the rectum and another to the womb, are the last which the hypogastric gives off before it degenerates into a ligament.

### ARTERIA HÆMORRHOIDEA MEDIA.

The middle hæmorrhoidal artery is not a large branch. Often we do not find it, but other arteries

supplying its place: sometimes again it is so large as to give off both the uterine and the lateral sacral arteries; but in general it is small. It comes off from the hypogastric opposite to the glutæal artery (presently to be described); it touches the rectum below its middle, and descends curling and winding chiefly along its fore part quite to the anus; and often it gives, as it runs betwixt the rectum and bladder, arteries to the bladder, prostate gland, and vesiculæ seminales. It is this artery also which in women gives small branches to the vagina.

### ARTERIA UTERINA.

The womb has four arteries, two from each side; the uppermost that which enters by the upper corners of the womb, comes from the aorta, corresponds with the spermatic in Man, runs along the broad ligament towards the ovaria. The lower artery of the womb, and the largest, comes from the hypogastric, enters the womb, where it is connected with the vagina, and runs upwards along the sides of the womb to meet the spermatic; and it sends also at the same time branches downwards into the vagina, and forwards upon the bladder, where it adheres to this part of the womb.

This uterine artery arises from the hypogastric near the origin of the hæmorrhoidal artery; and when it enters the womb it becomes very tortuous.

These, then, are the chief arteries of the rectum, bladder, womb, vesiculæ seminales, and other parts within the pelvis.

## ORDER SECOND.

### OF THE ARTERIES WHICH GO OUT FROM THE PELVIS TO THE HAUNCHES, HIPS, AND PRIVATE PARTS.

In this second class or order there are just four great arteries; one which goes over the back of the haunch-bone to the glutæal muscle, named Glutæal

artery; one going downwards over the tuber ischii to the hip, named the Ischiatic artery; one which goes out of the pelvis, returns into it again, and passes out a second time by the root of the penis, named the Pudic artery; and one which passes out through the thyroid hole into the deep muscles at the top of the thigh, named Obturator artery. All these larger arteries go off from the convex of that arch which the hypogastric forms, and move backwards and downwards, in order to escape from the pelvis.

Let it be remembered, that the iliac artery forks just at the meeting of the ilium and sacrum; that the great sacro-sciatic notch is formed by this joining of the ilium and sacrum, and is just under the junction of these two bones: that the glutæal artery passes out by this sacro-sciatic hole; and that of course it is the first, as well as the greatest, of those three arteries which turn backwards out of the pelvis.

### ARTERIA GLUTÆA.

The GLUTÆAL ARTERY goes off from the internal iliac immediately after the lateral sacral arteries. It is exceedingly large, thick, and short, within the pelvis, for it immediately turns over the bone: the turn which it makes over the naked bone is backwards and upwards; it instantly divides itself into a great leash of vessels, which spread in every direction, supply the two glutæal muscles, and turn and ramify upon the back of the haunch-bone, just as the great scapular arteries play over the surface of the scapula.

The pyriform muscle goes out from the pelvis at the same great opening with the glutæal artery, and the artery is accompanied by some of the roots of the great sciatic nerve: the artery passes out over the pyriform muscle, betwixt it and the bone; and when the glutæal artery is to give out its branches, it splits into two great branches at the edge of the glutæus medius muscle. By this splitting, the glutæal artery is arranged thus: First, one great branch passes under the glutæus medius, of consequence it is naked upon

the back of the ilium; it sends one large and beautiful artery, which courses round the bone according to the line of the crista ilii, which supplies all the upper half of the haunch-bone with its nutritious arteries, and supplies of course all the upper half of the great or outermost glutæal muscle where it arises from the spine and dorsum of the ilium. Another large bunch, still belonging to this deeper artery, passes under the thickest part of the belly of the glutæus medius, lies upon the small fan-like muscle named glutæus minimus, and gives innumerable great branches to the middle and lesser glutæi muscles, and to the joint of the thigh-bone.

The other great branch of the glutæal artery slips in betwixt the glutæus major and the glutæus medius; and as it lies betwixt these two great muscles, it gives a prodigious number of branches to each, but chiefly to the great glutæal muscle.

### ARTERIA ISCHIATICA.

The SCIATIC ARTERY is so named, because, instead of going upwards with this crooked turn towards the haunch, it goes obliquely downwards to the hip, in the direction of the main artery from which it comes. It comes off from the iliac about an inch lower than the glutæal, and is next to it in size, almost equal, when (as it often happens) the pudic artery is derived from it. The glutæal artery should be contrasted with it thus: the glutæal goes out above the pyriform muscle; the sciatic goes out below it; the glutæal turns upwards over the haunch-bone, the sciatic turns downwards along the hip; the glutæal spreads its arteries wide with sudden and crooked angles; the sciatic sends its arteries downwards in a gentle waving form, or almost straight, and so numerous as to be compared with a lash of many thongs proceeding from one shaft.

Often the glutæal artery, before it passes out of the pelvis, gives small twigs to the rectum, to the bone, and to the pyriform muscle; and in like man-

ner the ischiatic, before it escapes from the pelvis, gives also trivial branches to the rectum, and to the pyramidal muscle.

The branches of so great an artery, ramifying merely among muscles, and among such a vast variety of muscles, can neither be named, nor are worth naming. All that is to be desired is, to know the trunk, and the general direction in which its greater branches go. Among these branches there are few remarkable.

First, The COCCYGEAL ARTERY turns quick backwards upon the sciatic ligaments, and lying under the glutæus magnus; and passing along by the direction of the ligament, it arises at that part of the sacrum whence the ligament takes its rise; and turning downwards upon the coccyx, and upwards upon the back of the sacrum, it inosculates with the sacral arteries through the posterior holes. Secondly, Another branch, more remarkable for its office than its size, runs downwards along the sciatic nerve, supplying its coats and substance. But the great branch of this artery sends a confused lash of arteries downwards, which give arteries, first to the glutæal muscles and pyriformis, and then downwards to all those muscles of the back of the thigh which arise about the knob or tuber of the ischium. In short, all its chief branches are muscular; and the artery is remarkable for no other peculiarity than this, that its inosculations downwards with the reflected arteries of the thigh are so frequent, that these alone may save the limb in wounds of the femoral artery above its profunda, or that great branch which belongs to the thigh.

### ARTERIA PUDICA COMMUNIS.

The COMMON PUDIC ARTERY*, or the artery of the external parts of generation, is the third great artery which goes out from the pelvis backwards. And there

* It is named often the circumflex pudic artery, the internal pudic artery, the middle pudic artery, the great pudic artery.

is in the course of this artery a peculiarity which is never fully explained; and being unexplained, makes the succeeding description quite defective and lame: and it is this. The pudic artery (which is nearly of the size of a writing quill) usually comes off as a branch from the sciatic artery: it goes out from the pelvis along with the sciatic artery through the lower part of the sciatic notch, under the lower edge of the pyriform muscle, over the upper sacro-sciatic ligament. But no sooner has it made its appearance along with the sciatic artery, and emerged from the pelvis, than it returns into the pelvis again: it does not go over the outside of the tuber ischii, and so down to the perinæum; but it just appears out of the pelvis, rises over the upper sacro-sciatic ligament, gives out a few branches, turns in again under the lower sacro-sciatic ligament, or rather under the spine or sharp ridge of the tuber ischii, whence that ligament arises: it is now within the pelvis again; it lies flat against the inner surface of the ischium; it runs along by the direction of that bone till it approaches the symphysis pubis, where the root of the penis is. It there dives into the root of the penis, having just before given off that branch which goes to the perinæum. It is this long artery, running naked and unprotected along the whole inner side of the ischium, bending as the arch of the ischium and pubis bends, that is cut by ignorant lithotomists, which a broad gorget is sure to wound, and which can be safe only by our exchanging the gorget for the knife.

The branches of the pudic artery are chiefly these: First, Before it proceeds out of the pelvis, it usually sends branches inwards to the neck of the bladder, vesiculæ seminales, and prostate gland. Secondly, When it emerges from the pelvis, and while bending over the sacro-sciatic ligament, it gives, like the sciatic artery, chiefly muscular branches: it gives twigs to the sacro-sciatic ligament and pyriform muscle; others go to the gemini muscles, and turn over them to the great trochanter, and to the hip-joint, reaching as far

as the acetabulum; others spread over the tuber ischii, to which they give arteries, which go outwards along the three muscles of the thigh which arise from this point; and it sends inwards from this part an artery which encircles the verge of the anus, and belongs to the sphincter and levator ani muscles. This branch is named the LOWER OR EXTERNAL HÆMORRHOIDAL ARTERY: and other branches it sends forwards into the perinæum; but these are smaller and less regular arteries: they are not what are distinguished by the peculiar name of perinæal arteries. This artery, like the ischiatic, ends every where in inosculations with the reflected arteries of the thigh.

Thirdly, The artery returning again into the pelvis, and running along under the flat internal surface of the ischium, gives off many small branches to the bladder, prostate gland, vesiculæ seminales, and rectum. But when it has reached the perinæum, and is about to emerge from the pelvis a second time, and go into the root of the penis, it gives out three chief arteries; one to the perinæum, one to the body of the penis, one to the back of the penis, thus:

When the artery has approached nearly to the musculus transversalis perinæi, it splits into two branches; one of which is the artery of the perineum, the other is the proper artery of the penis.

### ARTERIA PERINÆI.

The ARTERY of the PERINÆUM passes under the transversalis perinæi and betwixt the accelerator and erector penis; in short, it comes out from that triangular cavity which we cut into in lithotomy; in which operation of course this branch cannot escape. The artery having escaped from this triangular cavity, runs forwards along the perinæum for two or three inches, according to the size of the subject, growing very sensibly smaller as it goes along. It is chiefly for supplying the skin and muscles of the perinæum; and gives these branches: 1. When it has just come out from the triangular hollow, it gives off from its

root one branch at right angles, which goes directly across the perinæum; it keeps the course of the transverse muscle; it may be named ARTERIA TRANSVERSALIS PERINÆI, and ends about the sphincter ani. 2. It gives branches to the accelerator and erector muscles. 3. It gives branches to the scrotum; and being continued along the corpus cavernosum of each side, it ends upon the tendinous sheath, which binds the corpora cavernosa. Thus ends the perinæal artery.

### ARTERIA PENIS.

The PROPER ARTERY of the PENIS is the continued trunk of the pudic artery. It is much larger than this perinæal branch; is as big as a crow-quill; it keeps still close to the bone, while the perinæal artery goes outwards; it at last touches the symphysis pubis, and of course pierces the corpus cavernosum, just where it takes its rise from the leg of the pubis: and here it splits into two great branches; one to the corpus cavernosum, and one to the back of the penis, or rather into three, since there is one also for the bulb of the urethra.

The bulb of the urethra is quite insulated in the perinæum, while the corpora cavernosa arise from the bone. Now, first, as the artery of the penis is passing by the side of the bulb, it gives off an artery to the bulb sidewise, which in part plunges into the bulbous substance, and in part is scattered upon the accelerator, prostate gland, &c.

Secondly, The artery having risen to the place where the root of the corpus cavernosum is, gives off that artery, which runs small and delicate along all the back of the penis, till it ends at last in a branch which encircles the corona glandis. This is named the arteria dorsalis penis.

Thirdly, The artery now plunges deep into the proper substance of the penis; the artery of each side goes into each corpus cavernosum at its root, and splits into two branches; these run chiefly along

the septum, or partition betwixt the corpora cavernosa, of each side. It is this artery which pours out blood so freely into the cells of the penis, and causes erection.

These three, the glutæal, the sciatic, and the pudic arteries, are the only ones which go out from the pelvis behind, and one only goes out by an opening on its fore part, or rather its lower part, viz. the obturator artery.

### ARTERIA OBTURATORIA.

The OBTURATOR ARTERY is so named from its passing through the thyroid hole. No artery is less regular in its origin; arising sometimes from the iliac, sometimes from the hypogastric, and not unfrequently from the root of the epigastric artery: in which case it turns back again over the pubis, coming into the pelvis behind the ring. But no artery is more regular in its destination; a considerable artery always passes through the thyroid hole, to supply the muscles which take their origin from the membrane, and from the ramus of the os pubis.

The obturator artery, arising from the iliac or hypogastric, runs along the upper edge of the pelvis, by the lower edge of the psoas muscle, accompanied with the obturator nerve, which is to go through the hole along with it. Having arrived at the fore part of the pelvis, it slips through the oval hole by a very small opening, which is in the upper part of the tendinous membrane, which closes that hole, and which is consequently at the upper edge of the obturator internus muscle. The artery, before it passes out of the pelvis, often gives branches of considerable size downwards to the neck of the bladder, prostate gland, and vesiculæ; to the iliacus internus, and psoas muscles, and to the lymphatic glands which lie upon them; and there is always a branch, which encircles the upper part of the foramen thyroideum, lies close upon the bone, and gives its twigs upwards into the muscles of the belly.

After the artery has passed along with its nerve through the thyroid hole, it comes into the very heart or central part of the thigh. Almost all its branches are muscular; none are worth distinguishing by name; it is only the general tendency of the artery that needs to be explained. It divides into two chief branches, taking opposite directions. The first is deeper; it turns downwards and outwards towards the hip-joint. It performs three services here; it gives, first, arteries to the periosteum, to the capsule, and to the gland within the acetabulum; it gives also large branches to the obturator, quadratus femoris, and all the great muscles which immediately surround the joint; it also forms very large and important anastomoses round the joint, with the sciatic and pudic arteries, from the pelvis, and with the reflected arteries from the thigh.

The more superficial branch of the thyroid sends all its branches into the great muscles upon the inner side of the thigh coming from the pubis. Its chief branches are to the upper part of the triceps muscle; it sometimes gives branches even to the superficial muscles, as the gracilis and sartorius; always, at least, small twigs pass through these muscles to the skin of the thigh and to the scrotum. Of these two arteries, this superficial one encircles the inner edge of the thyroid hole, or that which is next the pubis, with one of its branches; while the deeper artery encircles the outer edge, or that which is next to the hip-joint; so that they meet upon the bone inosculating with each other.

The following is a very common order of the branches of the

Arteria Iliaca Interna.
1. *Arteria Ilio-lumbalis.*
2. *Arteria Sacræ Laterales.*
3. *Arteria Hypogastrica.*
4. *Arteria Obturatoria.*
5. *Arteria Glutæa.*
6. *Arteria Ischiatica.*
7. *Arteria Pudica Communis.*

# ARTERIES OF THE LOWER EXTREMITY.

## ILIACA EXTERNA.

The EXTERNAL ILIAC ARTERY is that branch of the common iliac which descends under Poupart's ligament into the thigh. The internal iliac or artery of the pelvis parts from this within the pelvis at the joining of the ilium and sacrum. The external iliac passes down into the thigh, not bending along the upper edge or brim of the pelvis, directed by the lower edge of the psoas muscle, which also descends into the thigh. This great artery is accompanied by the anterior crural nerve; its corresponding vein lies by the side of it; the lymphatics of the thigh creep upwards along this artery into the pelvis; and when the artery descends into the thigh, it passes so over the bulging part of the acetabulum and head of the thigh-bone, that it is felt projecting there and beating with amazing force.

## ARTERIA EPIGASTRICA.

The EPIGASTRIC ARTERY, so named from its running up along the belly, goes off from the inner side of the external iliac artery about an inch before it passes out into the thigh.

The epigastric, when first given off, turns downwards with a full round turn till it touches Poupart's ligament. The peculiarity of its course here must be very carefully attended to. The femoral artery lies at the very outer margin * of the opening, called the crural arch. The Fallopian ligament forms the upper line of the crural arch. The epigastric artery moves inwards and downwards with the Fallopian ligament, running along its lower edge; then it crosses the opening called the abdominal ring, behind the ring,

* Viz. that end of the slit or arch which is nearest to the haunch-bone.

and also behind the spermatic cord which passes through the ring; then it mounts by the border of the transverse muscle, and gets to the rectus muscle of the belly; but it is pretty high before it touches the side of the rectus, and lying on the outside of the peritonæum, and on the inner surface of the rectus muscle, and keeping in the direct line of the rectus muscle near its centre, or rather nearer the outer edge of the muscle, and inclining inwards, it mounts from the groin to a little below the borders of the thorax, where it inosculates very freely with the internal mammary artery. These are the inosculations which were mentioned in speaking of the internal mammary artery. Through its whole course this artery is so large as to make its wounds important: we should know where to stop it in wounds; we should remember to avoid it in opening or extirpating tumours. I have seen some confusion and much loss of time during an operation, from not attending to this. The main artery must be remembered: its branches are of little value. The only branches which it is at all necessary to mention are, first, one small twig, which it sends downwards along the spermatic cord; soon after entering under the abdominal muscle, it gives off a large branch almost equal to the artery itself, which goes directly towards the navel, and ends there. This branch goes obliquely across the muscle, while the main artery follows the general line of the muscle, and gives branches on every side to the rectus, transversalis, obliquus; in short, to all the muscles of the abdomen, and spreads its last branches very freely about the lower border of the chest.

### ARTERIA CIRCUMFLEXA ILII.

The CIRCUMFLEX ARTERY of the HAUNCH is named CIRCUMFLEXA from its turning directly backwards, and ILIUM from its passing along the hollow of the haunch-bone.

It is smaller than a crow-quill; it goes off from the outside of the external iliac artery opposite to the epi-

gastric, or rather a little lower; exactly at that point where the outer end of the Fallopian ligament begins in the haunch-bone. It runs backwards in a curved line along the hollow of the haunch-bone, curving along the crista ilii, or ridge of the ilium, under which it lies. Its line is along the most naked part of the bone, where the internal iliac muscle begins on one hand, and the transverse muscle of the belly on the other: in short, it runs along all the upper edge of the internal iliac muscle, quite round almost to the lumbar spine, where it joins the ileo-lumbar artery by small inosculations; for at this place the reflected iliac artery, which grows gradually and sensibly smaller, is almost spent. There are no remarkable branches which deserve to be described, or even to be named, unless it be one which goes off early, near the head of Poupart's ligament, and gives branches to the ligament, to the sartorious muscle which arises at the same point of the haunch-bone, and to the edge of the iliac muscle. And as it runs along betwixt the iliac muscle on the one hand, and the transverse of the belly on the other, it gives many branches downwards to the internal iliac and psoas muscles, and to the substance of the bone; and upwards it gives three or four branches into the abdominal muscles, which go so far along the belly as to inosculate with all its other arteries.

### THE CRURAL ARTERY.

The projection of that part of the great artery which is very often called the femoral artery, but with more propriety the crural artery, is occasioned not merely by the naked pelvis and the head of the femur; these parts are covered by the flesh and tendons of the psoas magnus and iliacus internus, which also come out from the pelvis to the thigh. The artery lies cushioned upon these muscles; the muscles dive very deep to get at the trochanter minor or inner trochanter of the thigh-bone. The artery follows them; and thus it is plunged as it were into

a deep cavity, assumes a new position, and this constitutes a second point of description.

The hollow in which the artery now lies may be compared with that of the bend of the arm. The artery now takes the name of femoral, lies deep in a hollow surrounded by much fat and many glands; the cavity is covered with a very strong fascia, or tendinous sheath, which descends from the muscles of the belly over Poupart's ligament, and which is greatly strengthened at this point by the general fascia of the thigh. Here the femoral artery, instead of sending off less effectual branches from point to point as it moves downwards, and which could not have conveniently penetrated through all the thickness of the thigh, sends off one great branch, which furnishes the thigh, whence it is named the muscular artery of the thigh. This great artery goes off from the femoral artery just like the ulnar from the artery at the bend of the arm, *i. e.* very deep among the muscles, in the triangular cavity above described. Thence it is oftener named profunda than muscular artery.

The artery having sent down this great branch, equal almost to itself in size, is now properly the femoral artery, (arteria superficialis femoris): and now it inclines outwards again, meets the inclined line of the sartorius, and passes obliquely under it, and is covered by it and by the fascia. It is felt beating along the line of the sartorious muscle; and by that line we apply the cushion of our tourniquet. It retires from our feeling only about two hands' breadth, or a little more, above the joint of the knee; at which place it perforates the triceps or great muscle of the thigh, gets from the fore to the back part, or, in other words, forsakes the thigh to go down behind into the ham, where it exchanges its name for that of popliteal artery.

The popliteal artery, when it has got into the ham, meets with its corresponding nerve, which is of vast size; and the artery lies now flat upon the back part of the thigh-bone, passes down in a hollow formed

betwixt its great condyles, lies flat upon all the back of the knee-joint, is enclosed by the two great ham-string muscles from above, and by the two great heads of the gastrocnemii muscles below. But although we say it is protected, yet in truth it is not tightly bound down by a fascia embracing it, but lies on the contrary so loose and unsupported among the cellular substance, that we have the most certain evidence of its being often racked and strained in sudden or awkward motions of the joint.

From the ham, the artery descends into the leg, under the heads of the gastrocnemii muscles; and being lodged behind the great bulging, or head of the tibia, below the joint, it there divides into three great arteries. One passing down behind the tibia is named posterior tibial artery; one perforating the interosseous membrane goes down along the fore part of the tibia, is named tibialis antica; the third artery, passing down behind the fibula, is named the fibular or peronæal artery. These may be justly compared with the three arteries of the fore-arm; and as those meet in arches upon the palm of the hand, these meet and form similar arches on the sole of the foot.

Even from this slight and general description of this important artery, many conclusions may be deduced not indifferent to the surgeon; for there are several points in the course of this artery very peculiarly marked.

First, It is thrown so forwards by the bulging of the pubis, where it forms the socket for the thigh-bone, it beats so strongly just under the rim of the belly, that we cannot, at least till we try, doubt of its being easily compressed. I see, indeed, that Acrel, in very desperate circumstances, when his ligatures had given way even before his eyes, and the arteries burst, and after the surgeons had been twice deluged with the blood of the femoral artery, thought that he had suppressed this artery, by resting on it with his thumbs. But indeed the poor patient, under these horrible circumstances, as Acrel justly calls them,

must have fallen so faint and low, by a tedious alarming operation, and by the repeated bleedings, that any thing might have suppressed the pulse in the femoral artery, when that of the heart itself was well nigh gone.* But this is one of the points in which it is the most necessary for every man to speak from his own experience. I have tried it in the most favourable circumstances in a slender young man; and when I thought myself sure of the point, behold the blood gushed out with a whizzing noise and prodigious force. I have seen others try it, and fail. It is perhaps not impossible to compress the femoral artery; but it is not an easy thing, and is an expedient never to be trusted where the life of a fellow-creature is immediately in danger.† Secondly, The strong covering of the fascia gives a peculiar form to

* "His in horrendis angustiis, cum nec nova ligatura, nec torcularis contractione hæmorrhagia sisti posset, in trunco ipso, dum ex inguine prolabitur, pollicibus firmiter admotis, compressionem instituere placuit, quo effluxus substitit."

† It is strange that my brother came here so near the truth, and yet permitted it to escape him. And those who followed him, when they thought they were very sore upon him, were propagating the same error. Thus we know that a celebrated surgeon, in a public Hospital, gave this reproof to a pupil who still held out for the opinion of Mr. John Bell, "That it was dangerous to trust to compression." This surgeon was amputating without the tourniquet, and having by mere compression near the groin, stopped the bleeding from the femoral artery, he directed the stump in the face of the student, and let off a jet of blood upon him.

The fact is, as it is strongly expressed by my brother, the blood will flow, notwithstanding the utmost compression of the thumb or knuckle on the inguinal artery; and this he is quite right in asserting, "though as many devils as there are tiles in Bath were combined against him." The truth of the matter is, that if the inguinal artery were squeezed with a vice, the vessels of the thigh would bleed notwithstanding. Of this I had a good example to the point. A little fellow, a French doctor, allowing that he was not heavy, said confidently he could compress the great artery; for which purpose he mounted over my patient. I said to myself, "My little friend, do your best, but I wont trust to you." I began the high amputation by a cut with a scalpel, which laid bare the artery. I passed a ligature round it, and tied it. Then taking the amputating knife, I placed the edge in the first incision, and cut across

the aneurism of the thigh; it keeps it flat, forces the blood to spread abroad into the surrounding parts; and this deep driving of the blood among the muscles, together with the great size of the sac, and the putrefaction of three or four pounds of blood, causes that gangrenous and sloughing condition of the parts, by which we are so often foiled in our best concerted operations, and after the artery has been well and fairly tied. Thirdly, It is very obvious that the profunda might with more propriety be named the femoral artery, since it is the proper artery of the thigh; and though Heister, and some of the best among the old surgeons, spoke of this division as one which only sometimes took place, we know that a leg could no more be without a profunda than without what we call the femoral artery; and we also perceive, notwithstanding the doubts and fears of some modern surgeons, that when the femoral artery is wounded,

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the artery just below the ligature, and the muscles of the inside of the thigh, by one sweep; of course not a drop of blood flowed down from the artery, but it flowed the other way! it flowed back in pulses from the lower orifice! I remarked it to Mr. Shaw at the moment, who was assisting me, and he caught the orifice betwixt his finger and thumb. My reader will understand what happened. If I had made my incision in the usual way, I should have fallen into the belief of the surgeon who squirted the blood in the face of all unbelievers in his doctrine and practice. But as I had not divided the collateral branches, and only the trunk itself, the reason of the discrepancy of opinion was apparent; compress the trunk ever so securely, if you leave the circuitous circulation free, the blood will flow during any operation on the thigh; and, practically considered, my brother is quite right: do not trust to compression, or you will be convinced of your improper boldness, by being deluged with blood. You may in any operation, grasp the thigh with your hands, as surgeons did before the invention of the tourniquet, and stop the hæmorrhage from the face of the stump. Under this security, if you can trust to the strength of your assistant's grasp, you may perform any operation. But if you compress the femoral or crural artery alone, and if you allow the vessels of the perineum, and hip and thyroid hole, to be free in their connexion with the vessels of the thigh, you will have a full tide of blood, and all the consequences which you might expect from an unrestrained femoral artery.—C. B.

it is after all, only a wound of the artery of the leg. Fourthly, The large branches which the profunda sends upwards round the haunch, inosculating with the sciatic and pudic arteries, and the branches which it sends downwards to the knee, inosculating round that joint with the arteries of the leg, make this branch of peculiar importance to the surgeon; for when the artery is wounded in the groin, above the profunda, this branch saves the thigh, by its inosculations round the haunch; and when the artery is wounded in the thigh, below the profunda, or in the ham, it saves the leg by its inosculations round the knee; and when the whole line of the femoral artery has been obliterated, it has saved the whole extremity, as I have elsewhere proved, by receiving the blood from the arteries round the haunch, and conveying it down to the arteries below the knee, being thus an intermedium betwixt the internal iliac artery and the arteries of the leg, capable of forming a new line of circulation behind the thigh when that before is shut up. Nor should it be forgotten, that the aneurism on the fore part of the thigh may proceed from the profunda; and then the femoral artery which lies before it may be cut across by a rash or ignorant surgeon.

Fifthly, The place of the femoral artery passing through the triceps muscle is next to be observed, for these reasons. At that point it lies close upon the bone; and as this happens exactly at that distance above the knee at which we usually amputate, we expect in such amputations to find the great artery close by the bone. As the artery is at this point tied down by the tendon of the triceps, and is in fact passing through a tendinous ring, it sometimes happens that when we have cut near this, but not upon it, the flesh shrinks in such a way that even this great artery, though it bleeds, is not easily found; but one stroke of the scalpel, running along the bone, cuts the tendon up, and exposes the artery with open mouth. This single point makes all the

difference betwixt an aneurism of the thigh and of the ham; it is peculiarly necessary to mark this, in order to ascertain the extent of the disease before beginning an operation. Nothing can have a worse appearance than that which has actually happened, viz. a surgeon beginning that operation in the ham, which he should have attempted rather on the fore part of the thigh; and being forced to change his ground, and to begin a second operation on the fore part of the thigh, or, what is worse, to cut up the tendon, and follow the diseased artery to the fore part of the thigh, cutting, in short, first longitudinally betwixt the hamstrings, and, after an hour's working, perhaps cutting, cross-wise to reach the fore part of the thigh.*

Sixthly, Is it not a matter of very high importance to study the ham still more carefully than the axilla, since the artery is so often hurt at this place by rude motions of the joint? For it is a narrow cavity; the artery lies close upon the joint and bones; and when it is allowed to remain long in a diseased state, enlarging and dilating the ham, we perform in the end a hopeless operation; or if we had hopes when we began our operation, they are all over before it is ended: for the parts are found to be diseased, the bones carious, the joint spoiled; there are no hopes even of present safety, and of the ligature holding, and much less any expectation of a permanent cure. Often the greatest surgeons have been contented to finish such an operation by cutting off the limb! †

Seventhly, When the artery has gone down beyond the ham, and seems lodged safely under the gastrocnemii muscles, still it is not safe: it is bended tense over the back of the joint; it is pressed by the gastrocnemii stretching over it; and their violent action has often been such, as to have torn the

* Such operations certainly were performed before the improvement of Mr. Hunter, and from the inflammation produced, the operation could not succeed.

† Again this refers to the miserable operations for popliteal aneurism performed before the time of Mr John Hunter.

artery with a tumour so immediate, and with such excruciating pain, that the surgeon has been constrained in a manner to cut off the limb even upon the spot.

Eighthly, Very often we are obliged to decide, whether a tumour of the thigh or a tumour of the ham can be cut away, only by our knowledge of these arteries. How often the anterior arteries of the leg are cut by workmen, and how much they are exposed to the stroke of the adze or axe, every practical surgeon must know: but the mischances that open arteries are quite unthought of. I have known a man standing carelessly by his scythe, which was set upright, the blade along the ground, and the shaft resting upon his arm, cut the artery behind the outer ancle so as to form (when the wound healed) a large, livid, and strong-beating aneurism ready to burst, and requiring immediate operation.

The epigastric artery is in danger in operations for hernia. The femoral artery is the subject of operation for aneurism; the popliteal aneurism is a disease of this artery in the ham; and even the simple operation of amputating either the limb itself, or tumours in the thigh or ham, requires a perfect knowledge of all these arteries.

But although no formal operation affected these lesser arteries, yet the main artery itself is so exposed, and so superficial where it runs down the thigh, that it is wounded in a hundred various ways. It is very singular how often it has been wounded by one particular accident, viz. the dropping of a pair of scissors, and with a sudden instinctive effort, clapping the knees together to catch them. It has been wounded once or twice by a shoemaker clapping his knees thus together to catch his sharp-pointed paring knife. One of my pupils lay three months in London, uncertain whether his femoral artery was wounded; for he had in this way caught his penknife, the point of which had run into his thigh, and wounded some great artery. It has been cut across by balls; it has been wounded even by a single slug;

it has been uncovered by wounds which yet did not touch its coats, and has in consequence dilated into an aneurism. I have known a boy stab another with a pen-knife in the thigh, and strike so critically as to open the artery with a wound like that of a lancet. My friend Mr. Harkness gave me the privilege of dissecting an aneurismal limb which he was obliged to cut off; and in which the artery was (if I may use such an expression) broken or torn across the upper end of the thigh-bone, which had been broken by a fall about three weeks before.

All these accidents must come upon the surgeon very suddenly; and if they come upon him unprepared, all is in a moment lost. I once saw a fine young fellow die from this alarm of the attendants and confusion of the surgeon. He was a tall, stout, young man, who was sitting at table with his companions, eating bread and cheese, taking his glass and telling his tale. He had in his hand a sharp-pointed table-knife, which he happened to hold dagger-wise in his hand, and in the height of some assertion or oath he meant to strike the table, but the point missed, and slanted over the table; he had stabbed himself in the femoral artery, and with one gush of blood he fell to the ground. When I came, I found the young man stretched out upon the floor: he was just uttering his last groan; the floor was deluged, all slippery, and swimming with blood. The wound was covered with a confused bundle of clothes, which I instantly whirled off; and in that moment two gentlemen, who had been first called, and who had both run off for tourniquets (because tourniquets are used to stop bleedings) returned; and had the unhappiness to see that the hole was no bigger than what I could close, and had actually shut up with the point of my thumb; and which, had it been shut and put together with a good compress, would have healed in three days, forming a large beating aneurism within, allowing time for a deliberate operation. Or it would have been better still, if by compressing

the artery above, and enlarging the wound, a ligature had been put on both ends of the divided vessel.

In short, to enumerate the variety of accidents which may affect this artery, would be impossible; but surely, from the little that I dare venture to say in this place, it must seem one of the largest, the most exposed, and most dangerous, and by all this the most important, artery in the body; and from these previous hints and general descriptions, the value of the several branches which are now to be enumerated will be more easily felt and understood.

### BRANCHES OF THE CRURAL ARTERY.

The great crural artery, until it gets down into the hollow which I have described, gives no branches, or none with which I would choose to confound the description of the profunda or great artery of the thigh. The crural artery betwixt the point where it comes out from under the Poupart ligament, and where it sends off the profunda femoris, gives out several small arteries:

| | |
|---|---|
| ARTERIA CRURALIS. | 1. *Rami Inguinales.*<br>2. *Ramus Major.*<br>3. *Arteriæ Pudendæ Externæ.*<br>4. *Arteria Circumflexa Externa.*<br>5. *Arteria Profunda.* |

First, Twigs go out along the femoral ligament, and terminate in the skin. Secondly, Twigs go to the fat, and lymphatic glands of the groin. Thirdly, There ascends a small branch, sometimes towards the origin of the sartorius, to the middle glutæal muscles, and to the beginning of the fascia lata. Fourthly, Of those branches which go across the upper part of the thigh to the genitals, and which are named PUDICÆ EXTERNÆ, to distinguish their branches from those of the pudica communis, there are usually three. The uppermost is scattered about the fat of the pubis. The middle one goes across the heads of the triceps; it is longer and larger

than the others; it goes to the side of the scrotum and penis in Men; in Women it is large, and runs into the labium pudendi. The lower one of the three goes to the lower parts of the scrotum, and to the skin of the thigh near it.

### ARTERIA PROFUNDA FEMORIS.

Then comes off the profunda femoris, the DEEP OR MUSCULAR ARTERY of the THIGH. It arises from the femoral artery about four inches below the groin, more or less, according to the size of the subject. It turns off from the femoral artery with a bulging, which looks backwards and towards the outside of the thigh. It lies deep in the triangular cavity, upon the face of the iliacus internus and pectinalis muscles. It presently gives off two great arteries, which turn upwards along the joint; one round the outer side, the other round the inner side, of the joint. Then it passes downwards, turns in behind the femoral artery, sinking deeper and deeper towards the back parts of the thigh. It passes down along the face of the triceps muscle; and as it moves along its fore part, it sends through three or four great arteries to the back part, which are called the perforating arteries of the thigh. And, lastly, the profunda itself, or its last branch, passes through the triceps; and this last branch is named perforans ultima vel descendens femoris.

### ARTERIA CIRCUMFLEXA EXTERNA.

The CIRCUMFLEX ARTERY, which goes to the outside of the hip-joint, proceeds from the very highest point of the profunda. It takes its course outwards, passing under the sartorius, fascialis, and head of the rectus: it runs over the tendinous head of the vastus externus, where that muscle takes its rise from the outer trochanter: it divides very early into the following branches. First, Branches go to the inner side, to the internal iliac muscle, upon which this artery lies; and round it they bend over the lesser

trochanter, making inosculations with the internal circumflex artery. Secondly, An artery goes in the opposite direction, viz. outwards, to the iliac muscle, the sartorius, the head of the rectus, the fascialis, and round to the glutæal muscles. Thirdly, It sends many lesser branches upwards and forwards into the heads of those muscles which I have just enumerated, and which lie immediately over the artery. Fourthly, It sends large branches round the root of the great trochanter, some of them going into the hollow above the trochanter; others keeping so low as the root of the trochanter, where the greater glutæus is inserted. Fifthly, The most important of all its branches is a very long one, which it sends directly downwards under the rectus, or betwixt it and the vastus internus muscle. This artery is divided into two great branches, which run down the whole length of the thigh, somewhat resembling in their shape the PROFUNDA HUMERI: they are named the greater and lesser descending branches of the circumflex artery, and they inosculate in a most particular manner with a large anastomosing branch from the femoral artery. The larger branch of this artery emerges from betwixt the rectus and vastus externus, a little above the knee, to inosculate with one of the articular arteries of the knee. Its smallest branch inosculates with the anastomosing branch of the femoral artery. These two anastomoses seem to be the chief use of these two long arteries, though they do also send some branches to the muscles.

But to give a more simple notion of this circumflex artery, it should be described thus. It is divided into three chief branches: 1st, A descending branch, which goes down to the knee-joint; 2d, A transverse branch, which crosses the upper part of the thigh, and turns round the neck of the thigh-bone; 3dly, It sends a less important branch up upon the dorsum ilii.

## ARTERIA CIRCUMFLEXA INTERNA.

The INTERNAL CIRCUMFLEX ARTERY is a thick short artery, which goes off opposite to the ball of the thigh-bone; and as the external one goes round the great trochanter, this goes round the lesser trochanter. It is a smaller artery; it has not so many muscular branches; it keeps closer to the joint; it goes off from the inner side of the profunda, just opposite to the circumflexa externa, or a little lower, but never more than an inch lower; it passes over the insertion of the psoas muscle, and under the belly of the pectinalis; it attaches itself then to the lesser or inner trochanter, and goes round the neck of the thigh-bone round the joint, and is expended on the muscles at the back of the joint, as the quadratus femoris, gemini, &c.

The artery having turned towards the inside, the muscles which lie there are the triceps, gracilis, &c. The first branches, therefore, which this artery gives off before it passes under the pectinalis, are to the triceps and gracilis. After having passed under the pectinalis, and while it is turning round the root of the lesser trochanter, it gives branches to the pectinalis and triceps; and especially it gives to the capsular ligament of the hip-joint an artery which is named articularis acetabuli.

The artery now lying upon the pelvis, under the neck of the thigh-bone, divides itself into two chief arteries; one goes upwards and forwards along the triceps, till it ends at last round the symphysis pubis. The chief muscular twigs of this branch are given to the triceps, and to the obturator muscles; it is this branch which inosculates so freely with the branches of the obturator artery; it is a twig of this artery which enters into the cavity of the hip-joint, by that breach which is in the inner edge of the acetabulum; and this branch entering then by its proper hole, goes to the gland in the bottom of the socket, or chiefly

to it. The other branch turns away in the opposite direction, viz. backwards betwixt the little and the great trochanter, turning round the neck of the thigh-bone. It gives branches also to the triceps and obturator, inosculating with the obturator artery. But its chief branches are towards the other side, as to the capsule of the hip-joint, to the neck of the thigh-bone, to the quadratus femoris. It is this artery which gives most of those branches about the roots of the trochanters named trochanteric arteries; and it is from this artery that many branches go backwards along the tuber ischii, to unite with those of the sciatic and pudic arteries.

### OF THE PERFORATING ARTERIES.

The two first perforating arteries are very large; the two next perforating arteries are smaller and less regular; the fifth perforating artery is just the termination of the profunda. But still it must be understood, that these perforating arteries are extremely irregular in place, size, and number, as indeed all muscular arteries must be; and that there are besides the greater perforating arteries many like them in this part of the thigh, though not distinguished by name.

### ARTERIA PERFORANS PRIMA.

The FIRST PERFORATING ARTERY is the largest branch of the profunda, bigger than both the articular arteries joined. It arises from the profunda, just under the lesser trochanter, betwixt the pectinalis and triceps brevis; and perforates the triceps about an inch below the trochanter, and close upon the thigh-bone. Here the artery lies under the lower edge of the glutæus, and close by the origin of the biceps, semi-tendinosus and semi-membranosus muscles, the three muscles which form the hamstrings; and the chief division of the artery is into one great branch, going upwards along the glutæus, and another going downwards along the flexor muscles. First,

The artery which goes upwards turns over the glutæus, spreads innumerable branches about the great trochanter; and meeting with the trochanteric branches of the arteriæ reflexæ, make a most beautiful inosculation, or rather net-work of inosculations, over the trochanter. Another transverse branch of this upper artery turns quite round the lower part of the trochanter, and round the thigh, among the flesh of the vastus internus; and a third branch of the same artery meets in inosculation with the lower branches of the sciatic artery.

The lower or descending branch of the perforans prima goes down along the three flexor muscles of the leg, viz. the biceps, semitendinosus, and semimembranosus; nourishes their fleshy bellies, and plays over their surface in beautiful net-work.

### ARTERIA PERFORANS SECUNDA MAGNA.

The SECOND OF GREAT PERFORATING ARTERY is a much larger and more important branch of the profunda than this first, at least it is so when the other perforating branches are wanting, and when this, as often happens, represents the continued trunk of the artery: but I shall describe it as a second perforating artery to be succeeded by others.* The second perforating artery, comes off from the profunda, about two inches lower than the first; it passes through betwixt the first and second heads of the triceps, or through the flesh of the second; and turning obliquely downwards and backwards, close by the thigh-bone, it passes into the cellular interstice betwixt the flexor muscles of the opposite sides, *i. e.* betwixt the bellies of the hamstring muscles, and ends there.

Before it passes through the triceps, it gives branches to the triceps and vastus, and to the great trochanter, and to the thigh-bone. Its two chief branches, after it perforates the triceps, are, first, one

* My reason for saying this is, that sometimes there are but two perforating arteries, while there are often five which need to be described.

great transverse branch, which goes directly across below the tendon of the glutæus, and gives one great branch up upon the glutæus, and another to the vastus externus, making inosculations with the reflected arteries of the joint. Secondly, Its descending branch goes down in the hollow betwixt the great hamstring muscles, and its branches go into both muscles, but chiefly into the biceps, and in these the artery is exhausted.

### ARTERIA PERFORANS TERTIA.

The THIRD PERFORATING ARTERY comes off about a finger's breadth lower than the former; it makes a gentle waving turn inwards before it pierces the triceps; and after having perforated the triceps, it gives its branches to both the hamstring muscles, but chiefly to the semi-tendinosus.

### ARTERIA PERFORANS QUARTA.

The FOURTH PERFORATING ARTERY may be regarded as the last, or as the termination of the profunda, though sometimes there is a fifth. It perforates again still lower, about a finger's breadth below the last, through the flesh of the triceps magnus. Its first branch, while on the fore part of the triceps, is the nutritia magna femoris, or proper nutritious artery of the thigh-bone; and after it perforates the triceps, it gives its arteries to the two hamstring muscles, but more especially to the biceps; and so this last branch of the profunda ends.

But this minute description of any important set of arteries never presents any clear idea to the reader's mind, nor any knowledge which he can easily retain; I expect rather to do so by one short description.

The title of PERFORATING ARTERIES in one which comprehends all the great muscular branches of the profunda, except the two circumflex arteries belonging to the joint. They vary in number, as all muscular branches must do, and are proportioned in size and number to the bulk of the thigh. The profunda

passes down along the fore part of the triceps, while it is giving off these arteries; they must, of course, perforate the triceps before they can get to the back part of the thigh. When they do perforate, they come into a great muscular interstice or hollow which is formed by the hamstring muscles of opposite sides, by the biceps on one side, and by the semi-membranosus and semi-tendinosus on the other. It is to these two great muscles of the back part of the thigh that the branches of all the perforating arteries are chiefly directed. Each perforating artery succeeds another at about the distance of an inch or more; each successively coming out into this interstice at a lower and lower point. Each artery gives branches to the triceps, &c. before it perforates, and to the hamstring muscles, &c. after it has come into the hollow. The two first perforating arteries are the only arteries which are large and absolutely certain; the third is always very much smaller; the fourth is generally the termination of this great artery; the fifth perforating artery is rare.

Such a general idea as this of their size and value, and situation in the very heart or deepest part of the thigh, (for the profunda turns backwards from the very first, and all its branches keep the same direction,) is of more importance than a particular knowledge of every branch of each perforating artery; a thing really unattainable, since they vary more in their ultimate branches than almost any other arteries in the whole body; for they have more space, and a greater mass of irregular muscle to wander in, and produce varieties.

### ARTERIA FEMORALIS.

Though the profunda is plainly the artery of the thigh, yet from the ignorance of anatomists and surgeons, (who never knew till about twenty years ago that there was more than one great artery,) the superficial artery has been named the artery of the thigh.

The femoral artery makes a spiral or serpentine

turn round the whole thigh. It appears first on the fore part; it turns obliquely round to the inner side, following the lower edge of the sartorius muscle; it passes through the triceps, after it has got about two-thirds down the thigh, by which it gets into the ham, and its spiral turn is completed. It lies deep where it is giving off the profunda; it rises then, and is superficial all along the middle of the thigh; and when it has advanced two-thirds down the thigh, it again gets too deep to be felt; but all along it is covered by the thick strong fascia of the thigh. Through the whole of this course it gives no one branch out that is of any considerable importance. They are all muscular arteries, very small, nearly of one size, nameless, and undistinguished, going into the muscles of the fore part of the thigh; or if any are distinguished, it is only by their relation to other arteries, when the trunk gets low enough to make anastomoses with the arteries of the joint.

The nameless muscular branches of the femoral artery go, in one word, to all the muscles on the fore part of the thigh; to the rectus, sartorius, vasti, gracilis, and triceps; to the glands, fascia, fat and skin; and it thus continues giving successive branches to each of these long muscles as it passes the several points of them.

There is no distinguished branch till, having arrived within two hands' breadth of the knee-joint, it gives out, (just where it is about to pass through the tendon of the triceps,) a larger branch named (like a similar branch of the humeral artery) RAMUS ANASTOMOTICUS MAGNUS.

This branch goes out from the inner side of the femoral artery just where it is about to perforate the triceps; it passes into the flesh of the vastus internus; it first sends smaller branches to the vastus internus and sartorius, and through the interstice of these two muscles to the skin of the knee. But having penetrated into the fleshy belly of the vastus internus, this artery, which is itself very short and thick, sends out

its slender inosculating branches: one goes downwards along the tendon of the great triceps; and when the tendon of that muscle stops above the inner condyle, this artery goes forwards over the condyle, makes a net-work upon it, joining in numberless inosculations with the articular arteries from below, and gives twigs also into the joint. The other branches of this ramus anastomoticus tend all forwards and upwards to join the descending branches of the circumflexa externa, which come down along the rectus muscle.

There are two other arteries lying close upon the joint, remarkable enough to deserve a name, and they are called perforating arteries; not perforating like the branches of the profunda, to get deeper among the flesh; but perforating so as to get out from the cavity of the ham upon the surface of the thigh again.

The UPPER PERFORATING ARTERY arises from the inner side of the popliteal artery, just after it has perforated the triceps; but it must not be accounted a popliteal branch, because it immediately perforates the triceps muscle again. It gives branches to the semi-tendinosus, semi-membranosus, and sartorius; in short, it turns its branches towards the muscles on the inner side of the knee, and is a smaller artery.

The LOWER OR SECOND PERFORATING ARTERY goes off nearly opposite to this. It is a much larger artery. In order to escape from the ham, it perforates the shorter head of the biceps, or outer hamstring muscles. It first crosses the ham at its very upper point, and within the substance of the triceps; it then perforates the shorter head of the biceps flexor-cruris; it then emerges upon the thigh by the belly of the vastus externus muscle. Before it passes across the ham, it gives a branch to the semi-membranosus: while it is passing through the flesh of the biceps, it gives a lower nutritious artery to the lower and back part of the thigh-bone: after it perforates the biceps, all its branches are to the flesh of the biceps and

vastus externus, and its extreme branches are spent in inosculations with the descending branch of the circumflex or articular artery of the hip-joint.

But these branches, which are the last of the femoral artery, are extremely irregular. There is no artery from the profunda downwards worth naming, not even those which I have just described.*

## POPLITEAL ARTERY.

The artery having passed through the sheath or canal formed by the tendon of the triceps, or rather having passed betwixt the triceps and the bone, lies flat against the flat part of the thigh-bone as deep as possible in the cavity of the ham. There, as no muscles are lodged, it can give no muscular arteries of any importance; none but trivial ones to the hamstrings or to the heads of the gastrocnemii. In its whole length from the place of its perforating the triceps tendon to its great division, which is under the longer head of the solæus muscle, it gives none but articular arteries, *i. e.* small arteries to the knee-joint, which are no less than five in number, and encircle it in all directions.

First, The popliteal artery sends off from each side two muscular branches, not deserving a particular name nor description: the one goes to the biceps or muscle of the outer hamstring, the other to the semitendinosus and sartorius, or inner hamstring muscles.

Then come off the arteries of the joint, which are thus arranged: 1. The upper arteries coming off above the joint are three in number; one turning round the inner side of the joint, and one round the

* "Confiteri tamen oportet, binos ultimos ramos in distribuendis suis surculis infinite ludere, ita ut descriptione ad quodcunque cadaver adaptata vix, ac ne vix quidem comprehendi possint. Ex repetitis tamen meis dissectionibus id pro certe habeo, duos vel tres, quos perforantes appellare vellem, exoriri, hos trunculis suis ad externum latus præcipue conflecti cumque rete vasculoso genu jungi, nutritiant inferiorem ex iisdem gigni, et ramo insuper, nunc pauciores, nunc numerosiores, communicantes ad flexores cum profunda clevari."—*Arvidson*, p. 36.

outer side, and one in the middle; whence it is named azygous, as having no fellow. 2. The arteries below the joint are two only in number; one to the inner side, and one to the outer side, of the joint: and these directions of the arteries settle both the order of description and also their names.

### ARTERIA ARTICULARIS SUPERIOR EXTERNA.

That upper articular artery which comes off above the knee, and which turns round the outer side of the joint, arises from the popliteal artery above the outer condyle: its trunk is, like all these arteries about the joints, short and stumpy; but its branches long and slender. It passes under the flesh of the biceps; it appears again at the edge of the vastus externus: one branch plunges into the vastus externus, mounts upwards, and, besides supplying the muscle, inosculates with the long descending branch of the circumflexa externa; while another branch turns as directly downwards over the face of the outer condyle, and spreads beautifully over the side of the joint, inosculating in many net-works with the corresponding artery from below.

### ARTERIA ARTICULARIS SUPERIOR INTERNA.

The UPPER ARTICULAR ARTERY of the INNER side goes off in like manner over the inner condyle, pierces the tendon of the triceps, where it is implanted into the condyle, and passing under the edge of the vastus internus, turns towards the fore part of the knee, proceeds towards the patella, and covers chiefly the inner side of the joint with its net-work of inosculations: its little twigs slip in under the great lateral ligament, and under the sides of the patella, to the cavity of the joint itself. It inosculates like the outer artery with the lower arteries of its own side.

### ARTERIA ARTICULARIS MEDIA.

The MIDDLE OR AZYGOUS ARTICULAR ARTERY usually arises from the back part of the popliteal artery, but

sometimes from one or other of those last described; but this branch, at all events, is seldom wanting. It runs down behind the main artery upon the back part of the joint, into the great hollow betwixt the condyles; and all its branches are expended upon the back of the capsule, the posterior crucial ligament, the semilunar cartilages, and the fat about the back of the joint.

### LOWER ARTICULAR ARTERIES.

The lower articular arteries are more slender, longer, run downwards very slow, and return upwards with a very sudden angle.

### ARTERIA ARTICULARIS INFERIOR EXTERNA.

The external ARTICULAR ARTERY below the KNEE goes off from the popliteal at the middle or centre of the joint, turns downwards along with the popliteal artery for a considerable way; it passes under the heads of the small plantar muscle and the outer head of the gastrocnemius, and having passed through, encounters the head of the fibula, and passes above it to the side of the joint, spreading its branches towards the patella.

In the ham this artery gives muscular branches to the heads of the muscles, as of the gastrocnemius, solæus, plantaris, and the popliteal muscle, that muscle which lies obliquely across the ham. When it reaches to the side of the joint, it passes under the external lateral ligament; and several of its branches, besides their external anastomoses, go into the cavity of the joint, one of which, within the joint, is especially large.

### ARTERIA ARTICULARIS INFERIOR INTERNA.

The INTERNAL ARTICULAR ARTERY below the knee is larger than the external one. Like it, it bends downwards, passes under the inner head of the gastrocnemius muscle, crosses behind the head or rather neck of the tibia, on the inner side of the knee. It

first gives arteries to the back of the joint; then it communicates downwards with a large recurrent artery from the tibialis antica; it inosculates upwards with the articularis superior interna; it contributes (as all the other articular arteries do) to the forming of that profuse net-work of arteries which is spread over the whole of the capsule of the knee-joint. It sends also, like the others, certain twigs, which creep under the internal lateral ligament, and go into the cavity of the joint along the borders of the semilunar cartilages.

Before the popliteal artery passes under the head of the solæus, it gives two long arteries, which run down upon the two heads of the gastrocnemii muscles. It often also sends small twigs to the head of the solæus, and to the popliteal and plantar muscles. These are of size to require ligatures in an amputation below the knee, and are named surales.

### RECAPITULATION AND PLAN OF THE

| | | |
|---|---|---|
| FEMORAL and POPLITEAL ARTERY. | 1. *Rami Irregulares Musculares.* | |
| | 2. *Ramus Anastomoticus Magnus.* | |
| | 3. *Rami Perforantes.* | |
| | 4. *Arteria Articularis Superior Externa.* | *Ramus Profundus.*<br>*Ramus Superficialis.* |
| | 5. *Arteria Articularis Superior Interna.* | *Ramus Profundus.*<br>*Ramus Superficialis.* |
| | 6. *Arteria Articularis Media.* | |
| | 7. *Arteria Articularis Inferior Externa.* | |
| | 8. *Arteria Articularis Inferior Interna.* | |
| | 9. *Surales.* | |

## OF THE THREE ARTERIES OF THE LEG AND FOOT.

The three arteries are, the tibialis antica, going on the fore part of the leg; the tibialis postica, passing deep along the back part of the leg; and the peronea, which is the smallest and least regular artery of the leg, and which has its name from passing down behind the fibula. The popliteal artery divides below

the ham, under the longer head of the solæus muscle, into two arteries, the tibialis antica, and tibialis postica. The tibialis postica continues its natural direction downwards under the solæus muscle, and behind the tibia.

### ARTERIA TIBIALIS ANTICA.

The TIBIALIS ANTICA makes a sudden turn forwards, perforates the interosseus membrane just under the lower edge of the popliteal muscle; passes out towards the fore part of the leg, betwixt the heads of the tibia and fibula: but still it does by no means become a superficial artery: on the contrary, it lies deep under the heads of the tibialis anticus, and the extensor of the toes; which are covered here with a very strong fascia. It is only about two inches above the ancle that the leg grows tendinous and naked; there this anterior artery can be felt beating: it lies betwixt the tendons of the tibialis anticus muscle and that of the extensor of the toes; it passes down along with these tendons through the annular ligament, and over the bones of the tarsus: it sends one branch across the foot, another forward to the great toe; but the artery itself dives betwixt the first and second metatarsal bone in the middle of the foot, and so gets to the sole, where it ends in inosculations with the plantar arteries.

The tibial artery, before it passes out of the ham, gives a small branch which ascends towards the back part of the joint, and is distributed to the heads of the bones, viz. the tibia and fibula, and to the origin of some of the muscles.

### ARTERIA RECURRENS.

There is here an ANTERIOR RECURRENT, larger than any in the arm, and much resembling the recurrens interossea. It is a branch which comes off from the fore part of the tibial artery, instantly after it has perforated the interosseus membrane; it turns immediately upwards under the flesh of the tibialis anticus;

it gives many muscular branches, some to the head of the tibalis, others to the upper part of the extensor digitorum, and branches go round the head of the fibula to the origin of the long peronæus muscle. One branch goes directly upwards, and spreads all over the lower part of the knee-joint, mixing its branches in the common vascular net-work.

The tibialis antica gives no other branch of importance, or which should be named, even from the place of this recurrent quite down to the ancle-joint; for this, like the radial or femoral, or any long muscular artery, continues giving off branches from either hand to the muscles betwixt which it runs, of nearly equal size, and all equally unimportant. The tibial artery, then, as it runs down the fore part of the leg, gives branches to the Tibialis Anticus on one hand; to the Common Extensor of the toes on the other; and to the Extensor of the great toe, which is the last of the three muscles that occupy the fore part of the leg. It also gives little arteries to the tibia, to the fibula, and to the interosseus membrane which lies betwixt them; but still it arrives unexhausted at the fore part of the ancle-joint.

But before it crosses the joint, (which it does by passing obliquely along with the tendon of the great toe,) it gives out two malleolar arteries, *i. e.* two arteries, one to the outer, and one to the inner ancle.

### ARTERIA MALLEOLARIS INTERNA.

The ARTERY of the INNER ANCLE goes off just where the head of the tibia begins to bulge. It turns over the inner ancle in many small branches; some mounting upwards along the tibia, but more going downwards over the inner side of the joint, *i. e.* over the tibia or inner ancle, over the astragalus, and some down as low and as far backwards as the heel-bone.

## ARTERIA MALLEOLARIS EXTERNA.

The ARTERY of the OUTER ANCLE goes off a little lower down. It sends smaller branches upwards round the outer ancle, which go to the Peronæus Brevis muscle, to the joint, and to the common extensor of the toes, inosculating round the outer ancle with the fibular arteries. But its chief branch descends along the fore part and outer side of the foot, gives twigs to the short extensor of the toes, and ends in inosculations with the tarseal arteries, or arteries belonging to the fore part of the foot.

The arteries which belong to the fore part of the foot are usually three in number: one goes off from the tibial artery a little above the ancle-joint, and is named Arteria Tarsea, because it crosses the foot over the bones of the tarsus. To this succeeds a second about the distance of half an inch from it, and which crosses the foot at the place of the metatarsal bones; it is named Arteria Metatarsea: and the one or other of these gives the interosseous arteries, according as the one or the other is small or wanting. The third is that remarkable branch which goes forwards along the great toe, whence it is named Arteria Halucis.

## ARTERIA TARSEA.

The TARSAL ARTERY, which is sometimes of a very considerable size, almost equal to the tibialis itself, comes off a little below the ancle, upon the fore part of the foot. It lies upon the second row of the tarsal bones; it passes under the head of the extensor brevis of the foot; it crosses the foot obliquely, so as to end in the abductor muscle of the little toe, and in inosculations with the arches of the sole of the foot.

This branch gives small inosculating arteries upwards, which first give branches to the joint, and then join with the external malleolar and peroneal ar-

teries. Next it gives branches to the bones and joints of the tarsus, which it lies upon; as the cuboid and cuneiform bones, and their joints. Thirdly, It gives small arteries to the bellies of the extensor brevis, where it lies under it.

But its greatest arteries are the interosseous arteries, which it sends along the interstices betwixt the metatarsal bones. These interosseous arteries are three in number; they run along in that interstice which holds the interosseous muscles; and when they arrive at the end of that furrow, or, in other words, at the place of the forking of the toes, each interosseous artery turns down to the sole of the foot, and goes into the fork of each digital arch, on the lowest side of the toes. Sometimes these arteries give also small dorsal arteries to the backs of the toes.

The tibial artery having proceeded along the tarsal bones, and arrived at the lower heads of the metatarsal bones, and having first given off some trivial branches to the joints of the foot on its inner side, and to the bones and muscles about the root of the great toe, next gives off a metatarsal artery.*

### ARTERIA METATARSEA.

The ARTERY of the METATARSUS or instep goes off at the head of the first metatarsal bone. It bends across the roots of the metatarsal bones to the root of the little toe; and it distributes branches to the tendons of the peronæi muscles, and ends in the abductor of the little toe, and in the skin over the outer edge of the foot. But sometimes it is a larger and more important artery; for when the tarsal artery is small or wanting, this metatarsal one gives off the interosseæ, and supplies its place.

* *N.B.* — Betwixt the tarsal and metatarsal artery, there is usually a small branch going outwards to the outer edge of the foot, *i. e.* in the same direction with both these arteries, but very small.

### DORSALIS EXTERNA HALUCIS.

The third branch is the ARTERY of the BACK of the GREAT TOE. This artery is of very considerable size; it gives no muscular branches, because it lies upon the bony part of the foot; it runs all along the metatarsal bone which supports the great toe; and it ends at the forking of that toe in two great branches; one the dorsal artery of the great toe, which goes along it to the point; another to the side of the toe next the great toe, which it also runs along, somewhat like the forking arteries of the thumb and fore finger.

The anterior tibial artery ends here (*i. e.* where it gives off the artery of the great toe). By sinking in betwixt the metatarsal bones of the great toe and of the toe next to it, and going directly into the arches of the sole of the foot, it produces a great and important anastomosis, similar to that of the radial and ulnar arteries.

I have given here the most common distribution of those arteries on the back or upper part of the foot, but they are very irregular.

| | | |
|---|---|---|
| ARTERIA TIBIALIS ANTICA. | 1. *Arteria Articularis Tibialis.* | |
| | 2. *Arteria Recurrens Tibialis.* | |
| | 3. *Arteriæ Musculares.* | |
| | 4. *Arteria Malleolaris Interna.* | |
| | 5. *Arteria Malleolaris Externa.* | |
| | 6. *Arteria Tarsea.* | *Interosseæ.* |
| | 7. *Arteria Metatarsea.* | *Dorsales Digitorum.* |
| | 8. *Arteria Dorsalis Halucis.* | |
| | 9. *Arteria Profunda Anastomotica.* | |

### ARTERIA TIBIALIS POSTICA.

The POSTERIOR TIBIAL ARTERY is so named from its passing along the back part of the tibia. The anterior tibial artery passes through the interosseous mem-

brane only at the lower edge of the popliteal muscle: this artery comes off from the general trunk at the upper edge of the popliteal muscle, and passes obliquely towards the inside of the tibia, to take its place behind that bone. Its whole situation and general course is this: It lies under the fascia which covers the three lesser muscles on the back of the tibia, consequently under the solæus muscle, but over the tibialis posticus and flexor digitorum; coming near the foot; it turns round the inner ancle close upon the bone. Having passed the lower head of the tibia, it goes down along the inside of the heel-bone, in its deep arch, upon which the body is supported; it divides at the heel-bone, and advances along the sole of the foot in two great branches; one running along the sole, next the outer edge of the foot; the other along the inner edge of the foot; whence they are named external and internal plantar arteries. From this arch the artery gives branches to all the toes, and so it ends.

This posterior artery is chiefly a muscular one, at least in its course down the leg; and though it gives many branches as it passes along, there are hardly any worthy of being described: and from the knee to the ancle-joint there is one only which needs be distinguished by name, viz. the artery which nourishes the tibia.

First, The tibialis postica often gives arteries to the heads of the gastrocnemii muscles; next it gives off the ARTERIA NUTRITIA TIBIÆ, which begins a little below the lower edge of the popliteal muscle, runs downwards along the interosseous ligament, gives muscular branches to the popliteus, solæus, and tibialis posticus, and then sends the nutritious artery into the great hole in the middle of the tibia. It gives many branches to the periosteum of the tibia, and to the interosseous membrane all down the leg, and it ends near the lower end of the tibia in inosculations with the peroneal artery. This nutritious artery of the tibia is very important, from the peculi-

arity of its situation more than its size, for an artery in a bone being wounded or torn, bleeds in an extraordinary manner. I have seen the compound fracture of the tibia where this artery was torn, bleed so as to make the consultants imagine the main artery was torn.

Other nameless muscular arteries succeed to this, going to the tibialis posticus, to the flexor communis, and to the flexor of the great toe. When the artery arrives near the ancle-joint, it gives many small twigs to the periosteum, tendons, sheaths, and bursæ mucosæ behind the ancle; and then passing in the very deepest part of the ancle, under the annular ligament, and betwixt the tibia or process of the inner ancle and the heel-bone, it adheres closely to the bones and capsule of the joint; and there gives a great many little tortuous arteries, making net-works over this joint and its bones, as over the other joints already described. But especially two delicate arteries go out at this hollow at the side of the heel-bone: one forwards towards the side of the ancle-joint, the other downwards and backwards over the heel-bone, which ramify very profusely and very beautifully.

The artery now lying deep under the abductor magnus of the great toe, which arises from the heel-bone, forks into its two great branches, the external and internal plantar arteries.

### ARTERIA PLANTARIS INTERNA.

The INTERNAL PLANTAR ARTERY is much the smaller branch, not to be compared in importance (though their names are contrasted) with the external plantar artery; and it is named internal, because as it runs along the sole of the foot it keeps to the inner edge, viz. that to which the great toe belongs. It comes off under the head of the abductor of the great toe, and under the belly of that muscle, and close upon the bone; its branches run forwards, quite up to the root of the toe, all along its metatarsal

bone. The internal plantar artery has in general four branches, which all run pretty nearly in the same direction, viz. straight forwards.

It gives, while under the head of the abductor, small branches, which go backwards to the joint, its capsule, and tendons, and some into the spongy substance of the heel-bone; some also to the short flexor of the foot, and to the massa carnea. But its four greater and more regular branches are these:

The first lies nearer the inner edge of the foot; is the largest and most considerable; it runs along under the inner border of the abductor; it goes quite up to the ball of the great toe, and unites with the proper artery of the toe. As it goes along, it gives small twigs to the periosteum and bone.

The second resembles the former, except that it does not come off so early by two inches; it is of course shorter, but it passes along in the same direction, only a little distant from the first, lying along the middle of the metatarsal bone. It also advances up to the root of the great toe, and runs also into the proper artery of the great toe (which comes from the external plantar branch) so as to enlarge and strengthen it.

The third lies still nearer to the centre of the foot, and deeper among the muscles. It runs the same general course, viz. along the side of the metatarsal bone up to the ball of the great toe, and ending like the others in the artery of the great toe; but as it lies deeper, it gives branches to the short flexor, to the tendons, and to the inner surface of the aponeurosis plantaris, forming a sort of superficial arch.

From these three arteries, much of the skin on the sole of the foot has its branches.

The fourth and last branch of the plantaris interna, is one which goes down deep into the centre of the foot; it lies close upon those ligaments which bind together the bones of the tarsus, and under all the tendons, except those of the tibial muscles, which are like ligaments to the bones. Its destination is

chiefly to the tarsal joints and capsules; its inosculations with the external plantar artery can be of no importance.

PLANTARIS EXTERNA.

The EXTERNAL PLANTAR ARTERY is the greater artery of the sole of the foot, from which the arches of the foot and the inosculations with the anterior tibial artery are formed.

It turns outwards towards the outer edge of the foot; it runs its great circle round by the metatarsal bone of the little toe; and its plantar arch, or the arch of the sole of the foot, passes over the middle of all the other metatarsal bones. It receives the anterior tibial artery under the middle of the metatarsal bone of the great toe. It is this great curve of the artery turning round in the sole of the foot that we name the plantar arch; and it is from it that all the proper arteries of the toes arise, expressly after the same order in which the fingers receive their arteries.

The great or external plantar artery lies deep, but not upon the naked bones like the former. It passes through betwixt the heads of the short flexor and massa carnea; it turns its first turn outwards till it gets under the flexor and abductor of the little toe; then it turns inwards towards the centre of the foot, and lies between the tendonsof the flexor muscles, and the metatarsal bones and their interosseous muscles.

First, It sends a large branch backwards to the heel-bone, which belongs entirely to that spongy bone, forms, like all such arteries, a sort of net-work over all the surface of the bone; it first touches the bone under its extreme point, or that which rests upon the ground; and it goes branching over it so high as to inosculate round the ancle with twigs of the tibialis antica; it gives branches also hereabout to the great ligament of the heel-bone. The external plantar artery next gives branches to those muscles betwixt which it lies imbedded, viz. the flexor acces-

sorius and flexor brevis; then advancing to the side of the flexor digiti minimi, it gives out two or three branches, which first go into the flesh of the abductor and flexor of the little toe, and then turning over the edge of the foot, terminate in inosculations with the arteries of the fore part of the foot and in the skin.

It then begins from the root of the metatarsal bone of the little toe to form that great circle, which is named the arch of the foot, and which gives out two ranks of arteries: First, of interosseous arteries going to the spaces betwixt the metatarsal bones, upon which the toes stand; and, secondly, the proper arteries of the toes themselves.

The first of these arteries proceeding from the tarsal arch is a small one, the artery of the little toe. It begins at the lower head of the metatarsal bone, lies under the flexor and abductor muscles, gives branches to these muscles and to the skin, and to the bone itself; it runs up the outer edge of the little toe, and this is immediately succeeded by the first interosseous artery; which lies deeper, passes along the first interosseous space, gives branches to the bones and interosseous muscle, and inosculates betwixt the toes with the branches of the anterior tibial artery.

The next artery is properly the first of the great arch. It is what is called the RAMUS DIGITALIS, or proper artery of the toes. It is a long artery, runs over the interosseous space lying upon the interosseous muscles; it advances to the root of the little toe, and like those of the fingers divides into two branches, one to the inner side of the little toe, and the other to the side of the toe next it. A second and a third DIGITAL ARTERY go out in the same manner, and split at the roots of the toes into two branches, and with so little variety that it is needless to describe each part.

In the interstices of each of these arteries lie two or three small perforating arteries, which perforating betwixt the metatarsal bones inosculate with the

interosseous arteries which lie on the fore part of the foot.

But the great external plantar artery, while it is giving out these arteries alternately, *i.e.* large branches to the toes, and smaller twigs to the interosseous muscles, and some smaller still which go off from the concave part of the arch, and go into the sole of the foot to the ligaments and joints; the principal artery goes still onwards, and completes its arch at the middle of that metatarsal bone which supports the great toe. There, a little behind the ball of the great toe, it receives an anastomosing branch of the tibialis antica, which perforates from the fore part of the foot. This completes the arch of the anterior and posterior arteries, and permits the blood to pass, according to the pressure, or other accidents, in either direction; and this union strengthens and enlarges the artery of the plantar arch so much, that it is not exhausted by the many branches which it has given off, but gives at this point the largest artery of all, viz. the artery which supplies the great toe, one side of the toe next it. This artery of the great toe is the very last or extreme branch of the aortic system. It very closely resembles the great artery of the thumb; it gives out three chief branches, viz. one to each side of the great toe, and one to the inner side of the toe next it. This ARTERIA POLLICIS PEDIS sometimes seems to proceed entirely from the perforating branch of the anterior tribial artery; at other times it arises fairly from the plantar arch.

These lesser branches in the foot require a description as tedious as the larger arteries, and we have the more occasion for a plan, serving at the same time as a recapitulation.

**Arteria Tibialis Posterior.**

1. *Rami Musculares.*
2. *Arteria Peronæa.*
   - *Rami Musculares.*
   - *Arteria Peronæa Anterior.*
   - *Arteria Peronæa Posterior.*
3. *Arteria Nutritia Tibiæ.*
4. *Arteria Calcanea.*
5. *Arteria Plantaris Externa.*
   - *Ramus Transversus. Anastomoticus.*
   - *Rami Profundi.*
   - *Arteriæ Digitales 4tæ.*
   - *Arteriæ Interosseæ.*
6. *Arteria Plantaris Interna.*
   - *Ramus Anastomoticus Profundus.*

## ARTERIA PERONÆA.

The FIBULAR ARTERY, or the third artery of the leg, which is much smaller than the other two, in its course and connections, and its being exhausted nearly by the time it reaches the ancle-joint, greatly resembles the interosseous artery of the fore arm.

It comes off from the posterior tibial artery, near the head or origin of the tibialis posticus muscle, and accompanies that muscle down to the ancle-joint, lying betwixt the flexor pollicis and the acute edge or spine of the fibula.

This is entirely a muscular artery for supplying those deeper parts which the other arteries do not

supply. Its branches, like those of all muscular arteries, are extremely irregular; its chief branches are to the solæus, to the peronæi muscles, to the tibialis posticus, to the flexor of the great toe. Several little arteries turn round the fibula from point to point, going to the fore part of the leg. All the way down the leg, it is giving off repeated branches to the same muscles; and in this course it gives some little arteries, which pierce through the interosseous membrane, and also gives the nutritious artery of the fibula.

When it approaches the ancle-joint, the fibular artery gives off an anterior branch, which perforates the interosseous membrane, passes through betwixt the tibia and fibula nearly where they are joined; it turns downwards over the outer side of the ancle, by the extensor communis and peronæus brevis tendons. This is named PERONEA ANTERIOR, though it is an artery of little importance. Its branches are given not to muscles, for this is a naked and bony part of the foot; but are expanded upon the lower heads of the tibia and fibula, and upon the os cuboides. They nourish the tendons, ligaments, and bursæ of the outer ancle; they end in inosculations with the malleolar artery, from the tibialis anterior, and with the tarsal artery.

### ARTERIA PERONEA POSTERIOR.

As this ANTERIOR FIBULAR ARTERY branches over the fore part of the outer ancle, the POSTERIOR FIBULAR ARTERY passes deep behind the same ancle, and is just the continuation of the main artery; which having passed down behind the acute angle of the fibula, sinks into that deep hollow which is behind it upon the side of the heel-bone. Behind the tibia the artery makes large inosculations with the posterior tibial artery, and gives many branches to the tendons. Branches also turn round the ancle, making a net-work of vessels upon it, and inosculating with the anterior tibial artery. It continues to give the

same small arteries to the outer ancle, to the peronæi tendons, to the outer side of the heel-bone, and to the abductor of the little toe. It ends usually in that muscle, and in inosculations with that branch of the external plantar artery which turns backwards upon the heel-bone and ramifies upon it so beautifully.

These are the last branches of the three great arteries of the leg and of the aortic system.

## OF THE VEINS.

The veins are the vessels by which the blood carried outward by the arteries is returned to the heart. The system of the veins, however, is not so simple as that of the arteries, for while there are only two great arteries carrying the blood from the heart, viz. the aorta and the pulmonic artery, there are three great trunks of the veins, viz. the superior and inferior vena cava, which are the trunks of the great veins of the body; the pulmonic vein, which returns the blood to the heart from the circulation through the lungs; and the vena portæ, which collects the blood of the intestines, and conveys it to the liver. There is, besides, a greater variety in the distribution of the veins than in that of the arteries.

The French physiologists have departed from the old method of Harvey, in explaining the circulation. He wisely took the heart as the centre of the system, and described the vessels going out from it, forming the two circulations, viz. through the body and through the lungs; but they have assumed the lungs as the centre; and the veins of the body, and the arteries of the lungs, they call *systeme à sang noir*, because it contains the dark-coloured blood; and the pulmonic veins and the arterial system of the body

they call *systeme à sang rouge*, because it conveys blood of the bright vermilion colour.

This conceit is perhaps admissible, when introduced as an additional illustration of the relation of the lungs to the body; but it causes in a difficult subject an unusual degree of intricacy, and does not serve the purpose of demonstration: besides, the arteries and veins of the body, and the pulmonic artery and vein, have that strict and mutual dependance in action, which shows how improper and how unnatural it is to make this change, and to separate them in explaining the general system. At all events, let those who adopt this novelty cease to speak of the two circulations, for although in regard to the heart, there are two circulations, yet as the movement of the blood respects the lungs, there is only one. By this division, the blood returning from the body, and carried into the lungs, cannot be called a circulation; but only when it has passed through the lungs, and returned to the same point of its course through the body.

I retain the old method, corresponding with what has been delivered in the preceding volume, and in describing the veins will follow the course of the blood through them.

## GENERAL CHARACTER OF THE VEINS.

The capacity of the veins is greater than that of the arteries; the coats are thinner but stronger comparatively, and admit easily of dilatation to a certain extent. The coats of the lesser veins are comparatively stronger than those of the larger ones, and the veins of the lower extremity much thicker and stronger than in the upper parts of the body, as they have to bear a higher column of blood. The veins are transparent and the blood is seen through their coats. The veins have three coats. The *outer* coat is composed of a reticulated tissue of cellular membrane, which is wrapped somewhat loosely around the proper coats. The *second* coat has the same

character of an interwoven texture of filaments; but is more dense, especially on its internal surface, where it approaches the inner coat. The inner coat is dense and unelastic, resembling the inner coat of the artery, but stronger, more pliant, and less easily ruptured by a ligature than the inner coat of the artery. Betwixt all the coats there is a fine cellular substance interposed.* The inner coat being smooth and flexible is formed into valves in various parts of the veins; which valves are semi-lunar, and resemble those in the root of the great arteries in the heart.

In all the larger veins, excepting those of the viscera, of the abdomen, and those of the lungs and brain, there are valves; but in the smaller veins there are no valves: these valves, as I have said, consist of the inner coat, forming folds like a curtain, hung across the calibre of the vein; but at the same time attached so obliquely to the side of the vein, that they present a sacculated membrane, the edge of which is caught by the blood, the instant that the stream is retrograde, and thus the valve is raised, and falling back, stops the return of the blood against its natural course. The loose margin of the valve is somewhat stronger than the other part, and betwixt the duplicature of the inner membrane forming it some little filaments may be observed. Each valve consists, in general, of two semi-lunar membranes, the margins of which fall together; but they yield and give freedom to the current of blood when flowing towards the heart.

Authors have not noticed a part of the structure essential to the operation of a semi-lunar valve. I mean the little sinuses or more dilatable part of the coats of the veins just above the attachment of the valve. The sinuses are of the same use here, that they are at the origin of the great arteries from the heart. By their means the margin of the valve is not permitted to touch the side of the vein. The blood

* Unless near the auricle no muscular fibres have been observed. See *Halleri Opera Minora*, p. 175.

always intervenes betwixt the valve and the side of the vein, consequently the slightest retrograde motion of the blood throws down the valve. Without this provision, the valve being collapsed to the side of the vein, the blood would have been permitted to pass retrograde.

A ligature high on the arm or thigh not only causes the veins to swell by preventing the free course of the blood back to the heart, but it shows the veins in their distinct and natural character, and causes the sinuses of the valves to rise, showing the places of the valves.

The sacs formed by the valves of the veins are much deeper sometimes than the term semi-lunar implies, insomuch that the term pyriformis has been used. Neither are the valves always double, for sometimes they are single, and sometimes three in number.* They are best seen by opening the veins under water, and drawing them to and fro, by which it will be perceived how the valves rise and float.

As the veins are provided with valves only where they are exposed to occasional pressure, and particularly to the compression of the muscles, the use of the valves would seem to be, to prevent the retrograde movement of the blood, in consequence of the occasional and partial compression of the veins; but, no doubt, they at the same time support the column of blood, as in the lower extremities: and when those veins suffer distention by disease, a great aggravation of this condition is, that the valves lose their action, for the vein is now too large to be closed by them, and the whole column of blood presses upon the veins of the legs.

Fabricius ab Aquapendente, who discovered the valves of the veins, though ignorant of the circulation, and, consequently, of the true use of the valves, yet argues very ingeniously; for he imagined that exercise, by heating the limbs, would draw the blood from the trunk, to the injury and rupture of the

* Fabricius de Venarum Osteolis. Morgagni Epist. Anatom. XV. Kerckringii Spicilegium Anatomicum, Tab. 4.

vessels of the limbs, and the too great diminution of nourishment in the vital parts, were it not for the office of these valves. See, says he, how the veins swell, and the valves become marked and distinct, when a man is in full exercise. By this we may perceive, that exercise forces the blood out from the body towards the extremities, and would do it too powerfully, but for the operation of the valves. But Harvey, observing the mechanism of these membranes, was drawn to conclude that the blood must always run in one direction in the veins, and, consequently, that there must be a circulation of the blood.

The commencement of the minute branches of the veins is from the extreme ramifications of the arteries; they are continuous, and convey back the blood in that course which is called the circulation. In contemplating the capillary tissue of vessels, the most striking circumstance is, the predominance of the dark venous ramifications: and in general, two sets of veins will, even in these minute ramifications, be observed; one superficial, the other more intimately blended with the minute ramifications of the arteries; but in the internal parts of the body, and particularly the viscera, the veins uniformly accompany the ramifications of the arteries, and in the solid viscera, a dense cellular membrane gives lodgment to both sets of vessels.

It was supposed even after the time of Harvey, that there was a spongy or cellular substance betwixt the extremities of the arteries and veins; but there is no such thing in the microscope. I see the globules of the blood following each other in rapid succession, and turn, and accumulate, and retrace their course. There can be no doubt, that when they are passing rapidly, as one may say in single files, they are in the extreme arteries. That again, when they turn back, and go, two and two, or three abreast, they are in the extremities of the veins. I may further observe, that in the microscopical experiments we do not see the coats of these small vessels,

but must conclude, that they are there, from the globules of the blood being accurately confined to a certain tract or course.

In the extremities and head, indeed every where but in the viscera, the veins form two distinct sets; the deep and the superficial veins: 1. the deep veins accompanying the arteries; and 2. the sub-cutaneous veins, which emerge from the compression of the muscles, and run above the fascia. The union betwixt the branches of the veins is very frequent, not only betwixt the veins, ramifying in the same plane insomuch as to make them a net-work, but also betwixt the deep and the superficial set of veins: such are the venæ emissariæ of the skull, the free communications betwixt the external and internal jugular vein, betwixt the deep and superficial veins of the arm, &c. When in bleeding, the blood flows from the vein of the arm, accelerated by the working of the muscles, the blood escapes by the anastomosis, from the compression of the muscles, and fills the superficial veins; but the increase of the jet of blood is principally produced by the swelling of the muscles, causing the fascia to compress the internal veins of the fore arm.

In the dead body the veins are flat, but when distended, they resume the cylindrical figure which they possessed in the living body; yet they are in general of the cylindrical figure for a very small part of their course only, owing to the irregular dilatations by the side of the valves, and to the frequent union of their branches. The manner in which the branches join the trunk has a peculiarity which always distinguishes them from the ramifications of arteries: the arteries branch direct and at an acute angle, the veins in a direction more removed from the course of the trunk, and in general with a curve or shoulder.

In infancy and youth the veins are but little turgid, and especially the cutaneous veins are so firmly embraced by the elastic skin and cellular membrane, that they have a less degree of promi-

nency than in more advanced years. In old age the veins are enlarged, and rise turgid on the surface; the internal veins also become enlarged, and the whole venous system is extended.

Soemmerring says, with increasing years the resisting power of the veins is diminishing, that of the arteries increasing. I believe this to be incorrect in regard to both kinds of vessels.

I do not consider the change in the vascular system as the effect of mere distention, or of the enlargement of the veins, from the long continued action of the arteries; but as a necessary change in the proportionate distribution of the blood, which is preceded or accompanied with other peculiarities, which characterize old age. When we consider the great size of the veins, compared with the arteries, we must conclude that the blood flows but slowly in the venous system; that from the narrowness of the trunks of the veins near the heart, the blood must be accelerated as it approaches the heart; and that receiving the impulse from the ventricle, it must take a rapid course through the arteries, until, again approaching the extreme branches of the arteries, and passing into the veins, its motion becomes more languid and slow. In youth, as the size of the veins is not in so great a proportion to the arteries as in advanced life, the blood in a young person must be in more rapid and quick circulation: but in old age, owing to the largeness of the veins and the accumulation of blood in them, the blood moves slowly through the venous system, and is almost stagnant in the dilated veins and sinuses; upon the whole, it moves less briskly through the vessels, and the proportionate quantity immediately under the influence of the arterial system, is less than in youth.

There is no pulsation to be observed in the veins, but what they receive laterally from the contiguous arteries. There is no pulsation in the veins, because they are removed from the heart; because they do not receive the shock of the heart's action in their

trunk, but only by their widely-spread branches; because the contraction of the heart and of the arteries so alternate with each other, as to keep up a perpetual and uniform stream of blood into the veins; whereas the pulsation in the arteries is owing to the sudden and successive contractions of the heart.

In living animals I have undoubtedly seen the course of the blood in the great veins near the heart alternately checked and accelerated in its motion. But this is a subject which I have no disposition at present to pursue. This motion does not prove that there is here a muscular contraction.*

### FUNCTIONS, OR USES OF THE VEINS.

Are the veins merely for carrying back the blood to the heart, and are they entirely passive, while the arteries alone are agents? Although it appears that the veins have no muscular action in their coats, yet such is the peculiarity of their situation, that they become, in an indirect manner, powerful agents in circulating the blood. In the first place, we see that by their great number, their width, and large diameter, they contain a large proportion of the blood; in the second place, they are under the influence of the muscular system, so that every motion or effort compresses them, and causes a movement of the blood within them. If a long tube be attached to a vein of a living animal, so that the blood may rise into the tube, in height proportioned to the force of circulation, and if the animal be excited to exertion, in the moment of exertion, the blood is forced in a jet from the mouth of the tube. This explains what the influence of exercise must be, in accelerating the circulation. And now we see the proper use of the valves; for these sudden efforts of the muscular frame, compressing the veins, would cause a movement of the blood backward; the impulse would be at least as powerful retrograde upon

* *Haller* found contraction produced in the veins by touching them with oil of vitriol. *Opera Minora*, p. 375.

the course of the blood as forward. But as these flood-gates are thrown down on the slightest movements of the blood, contrary to the course of the circulation and the retrograde motion of the blood thereby prevented, the muscular force is all given in aid of the circulation, and the blood of the veins is thereby forced on to the right side of the heart.

In this general account of the venous system, it remains only to speak of the subject of absorption by veins. Before the suite of experiments made on this subject by Mr. Hunter, a vague notion was entertained that the veins were absorbents; but about that time*, the doctrine that lymphatics were absorbents having been established, the opinion that the red veins were also absorbents, was first questioned, and finally confuted, at least in the opinion of most physiologists.

The chief argument to show that veins, arising from cavities, particularly from the intestines, acted as absorbents, was, that some anatomists said they had seen white chyle in the blood taken from the mesenteric veins. It was, however, soon observed that the serum of the blood, taken from the veins of the arm, was sometimes white, which must arise from some other cause than the absorption of chyle.†

The experiments of Mr. John Hunter proved that there is no absorption of fluid from aliment contained in the intestinal canal, by the veins of the mesentery, while the lacteals were rapidly absorbing. Emptying a portion of the gut, and the veins of their blood in a living animal, he poured milk into the intestine. The veins remained empty and without a drop of the milk finding its way into them, while the lacteals became turgid with it. In another experiment, leaving the arteries and veins of the mesentery free, and the circulation through them perfect, still no white fluid could be discovered, tinging the stream of blood in the veins. Neither did pressure upon

* 1758.

† See Hewson, Exper. Essays and Lymphatic System.

the gut in any instance force the fluid of the intestines into the veins. He repeated and varied these experiments, so as to show, in a very satisfactory manner, that chyle, or the fluid of the intestines, never is absorbed by the veins.

Yet I must say that these experiments are still unsatisfactory, as they regard the general doctrine of absorption by the veins: in the intestines there is a peculiar set of vessels evidently destined to the absorption of the chyle and of the fluids of the cavity; but there remains a question which will not be easily determined: do not the veins throughout the body resume a part of that substance, or of those qualities, which are deposited or bestowed by the blood of the arteries? Are we assured that in the circulation of the blood through the lungs, and in the extremities of the pulmonic veins, there is no imbibing or absorption? In the veins of the placenta, there is not only an operation similar to what takes place in the extreme branches of the pulmonic circulation, but the matter and substance which goes to the nourishment of the fœtus, must be imbibed from the maternal circulation.* So by the vessels in the membrane of the chick in ovo, there is absorbed that which being carried to the chick, bestows nourishment and increase. If it be observed that in those operations of oxygenation matter is not absorbed, but only carbon thrown off, it only shifts the argument, without weakening it; for if the carbon be thrown off in the lungs, this carbon is absorbed by the veins in the circulation of the body, which amounts to the same thing to our present argument. For my own part, I cannot but suppose that, while the lymphatics absorb the loose fluids which have been thrown out on surfaces, or into cavites, the veins receive part of what is deposited from the arteries; but, which is not so perfectly separated from the influence of

* Dr. Hunter, Hewson, &c. say that it is probable there are many small lymphatics in the placenta, which open into the branches of the veins, and do nottake a course along the cord.

the circulating system, as that which the lymphatics receive; and that there are certain fluids, which, by an affinity of the venous blood, they imbibe in the course of the circulation. We must at the same time acknowledge, that the conclusions made in favour of absorption by veins, from experiments upon the dead body, are fallacious, and have no weight. It is seldom we can determine whether minute injections have taken a course by a natural or by a forced passage; neither are the experiments of some of the older physiologists more satisfactory or conclusive. Lower affirmed that, by throwing a ligature on the inferior cava of a dog, he produced ascites. He tied the jugular veins of a dog, and the head became dropsical. Hewson repeated these experiments, but without the same result. And if the tying of the veins had always produced œdema or dropsy, the experiment would have proved nothing more than is already established by the very common occurrence of œdema of the legs from the pressure of the womb on the iliac veins, or a tumour in the groin or in the pelvis. Now in these instances the compression of the vein does nothing more than cause a difficult circulation of the blood from the extreme arteries into the veins, and consequently a greater profusion of the discharge into the cellular texture by the serous arteries. But even the experiments of Mr. Hunter on the veins of the intestines, are not in unison with the experiments of Sir Everard Home, who finds that the matter in the stomach and intestines is received into the system, although the thoracic duct has been tied or cut.

On the whole, we must either admit absorption by veins, or that there are many communications betwixt the lymphatic vessels and red veins in the extremities of these vessels.

## OF THE VEINS, BRANCHES OF THE SUPERIOR VENA CAVA.

The superior vena cava, or the descending cava, is the superior trunk of the venous system; which receives the veins of the head, neck, and arms, and throws the blood directly into the great right sinus, or auricle of the heart.

But I hold it better to begin my description from the extremities of the veins, following the course of the blood. I therefore commence with the veins of the forehead.

### OF THE VEINS OF THE HEAD AND NECK.

The ANTERIOR FACIAL VEIN.* The facial, or anterior facial vein, runs down obliquely from the inner canthus of the eye, towards the angle of the lower jaw-bone. Here, uniting with the temporal vein, it forms the external jugular vein. The most remarkable branches of veins which assist in forming the facial vein, are the FRONTAL VEINS; which receive the blood from the forehead and frontal portion of the occipito-frontalis muscle, and the OPHTHALMIC VEIN, which is one of the emissariæ, and comes from the cavernous sinus through the orbit. In its course down the cheek, the facial vein receives the several cutaneous branches of the veins from the surrounding parts: but which have in reality no such importance as to require description. †

The POSTERIOR FACIAL VEIN ‡; or, GREAT TEMPORAL VEIN.— This vein descends from the temple before the ear, and passes through or under the mass of the parotid gland, and behind the angle of the lower jaw.

* *Facial vein; V. Angularis; V. Triangularis.*

† *Vena dorsalis nasi, superior et inferior — Vena palpebralis inferior externa et interna — Vena alaris nasi — Venæ labiales magnæ et minores, &c. — Venæ buccales, &c.*

‡ *Joannis Gottlieb Walteri, tab.* ii. 65. — *Venarum Capitis et Colli.*

This posterior vein receives those branches which are the proper temporal veins, and which are four in number, and descend upon the side of the head * ; and those which answer to the submaxillary artery, and also the vena transversa faciei, and the auricular veins. Finally, into some of the deep branches of this vein † the blood enters from the veins accompanying the arteria meningea. The posterior facial vein, uniting with the anterior one, forms a common trunk, which in general lies over the division of the carotid artery.

### EXTERNAL JUGULAR VEINS.

The external jugular vein lies under the fibres of the platysma myoides muscle, takes a course obliquely down the neck, and across the middle of the mastoid muscle, and drops either into the subclavian vein, or into the internal jugular vein. Sometimes there are two external jugular veins on each side; more commonly there are two branches high in the neck, from the anterior and posterior facial veins, which unite about the middle of it. When they are double they have this course; the *anterior and external* jugular vein may be said to begin from the anterior facial vein; it then receives the submental vein, which comes in under the base of the lower jaw — the ranine veins also, and veins from the glands under the jaw join it here: where it is before the mastoid muscle, it forms free communications with the internal jugular veins; and here also, it receives veins from the side of the throat. ‡

Almost all the ramifications of veins, which in one subject unite in the external jugular vein, and which come from the face and throat, do in others sink down into the internal jugular vein. §

* Being in two sets, the deep, and superficial. Walter, tab. ii. —*Vena tempor. superf.* 110. *et Vena temp. profund.* 111.

† *Viz. Venæ Pterygoideæ.*

‡ Viz. The superior thyroid veins, and the deep laryngeal veins.

§ Walter, loc. cit. tab. ii. 13.

Sometimes the anterior and external jugular veins join the internal jugular vein; sometimes the subclavian vein.

The POSTERIOR EXTERNAL JUGULAR VEIN is formed chiefly by the temporal vein, or posterior facial vein, which comes down from under the parotid gland; it is then joined by the occipital veins *, a little lower by the cervical veins, and lastly, on the lower part of the neck it receives the muscular branches from the flesh of the shoulder; it then sinks into the subclavian vein.

OF THE THYROID VEINS. — The thyroid gland has two sets of veins as it has of arteries; the *superior thyroid* veins carry back the blood from the muscles of the fore part of the throat, from the larynx, from the substance of the thyroid gland, and from the neighbouring part of the trachea and pharynx, and even from the fauces. Sometimes these thyroid veins enter the external jugular vein; sometimes they descend upon the neck, taking the name of GUTTURAL VEINS, and unite themselves with the internal jugular vein.

The LOWER THYROID VEINS come from the lower part of the thyroid gland, and descend upon the fore part of the trachea, and enter the subclavian; or, more generally, the great, or internal jugular veins.

OF THE INTERNAL JUGULAR VEIN. — JUGULARIS INTERNA. † — VENA JUGULARIS CEREBRALIS. ‡ — The internal jugular vein is formed by the conflux of the several great and posterior sinuses of the dura mater into the lateral sinus, which coming out by the foramen lacerum posterius of the basis cranii, ceases to be constricted into the triangular shape, and takes the form and peculiarities of a vein. From this foramen, common to the temporal and occipital bone, the jugular vein descends obliquely forward and downward, becoming from its deep situation somewhat

* These communicate with the vertebral veins, and through the posterior mastoid foramen with the lateral sinus.

† Haller, Icon. ‡ Walter.

more superficial, but in all its extent protected by the sterno-cleido-mastoideus muscle, and passes under the omo-hyoideus muscle. The internal jugular vein is very irregular in its form; being sometimes much contracted under the angle of the jaw; bulging and much enlarged, or rather capable of being much distended in the middle of the neck; and again contracted before it joins the subclavian vein. The carotid artery, the internal jugular vein, and the par vagum lie together in the same sheath of loose cellular membrane. The vein is to the outside of the artery, and the nerve is betwixt them, lying a little deeper.

The internal jugular vein receives these communications and branches: behind the angle of the lower jaw, a branch of communication generally goes down from the posterior facial vein, and often it is joined by the internal maxillary vein; under the jaw, it either forms free communications with the beginning of the external jugular vein, or it receives the ranine and guttural veins: at all events, there is a branch from the side of the throat and the muscles of the os hyoides, which passes into the internal jugular vein. From under the back part of the mastoideus muscle, the internal jugular receives branches from the occipital veins, and at the same time has communications with the vertebral veins. Near its termination the great jugular vein receives the guttural and lower thyroid veins.

Of THE VERTEBRAL VEINS. — There is difficulty in assigning origins to these veins, for they are rather like a chain of communication; they run in the holes of the transverse processes of the cervical vertebræ, and surround the processes with areolæ. First, a communication is formed with the great lateral sinus, then they receive the flat sinuses from under the dura mater, covering the cuneiform process of the occipital bone, (the basilar sinuses,) and as they descend they form transverse communications, which receive the branches of that chain of inosculations, which runs

down upon the spinal marrow. The vertebral veins, in their descent, send out divisions which run down upon the outside of the canal, and receive branches of veins from the muscles on the fore part of the vertebræ, and some of the proper cervical veins from behind. The *vena cervicalis,* coming from the side of the neck, unites with the vertebral vein near its termination, in the back part of the subclavian, or sometimes in the axillary vein.

### OF THE VEINS OF THE ARM.

The veins of the arm are in two sets, the venæ comites; and the external or sub-cutaneous veins, being those without the fascia, and not subject to the compression of the muscles. Of these, the latter are the more important and require a particular description.

On the palm of the hand, the veins are few and small, because they are there subject to compression in the frequent grasping of the hand; but on the back of the hands and fingers, the veins are numerous and large. The veins creeping along the fingers, make a remarkable inosculation on the back of the first phalanges, and then passing in the interstices of the knuckles, form a great and irregular plexus on the back of the hand*: the principal branch of which sometimes takes the form of an arch.†

The plexus of veins from the back of the hand is continued over the back of the wrist: when some of the larger branches, after playing over the heads of the radius and ulna, take a course, the one on the lower, and the other over the upper edge of the arm, whilst the back of the arm is left without any remarkable veins taking their course there.

The veins on the back of the hand have nerves intermingling with them, viz. branches of the ulnar nerve, and the extreme branches of the muscular spiral nerve; so that it is a great mistake to suppose that bleeding in the back of the hand might be sub-

* *Plexus dorsalis manus.* † *Arcus venosus dorsalis.*

stituted with advantage for the common operation in the bend of the arm, in order to avoid pricking the nerves.

Vena cephalica. — The vein of the back of the thumb running into a trunk, which takes a course over the outside of the wrist, is called cephalica pollicis.

From this vein and the division of the plexus of the back of the hand, a considerable trunk is generally formed, which takes its course on the radial edge of the arm, and is called cephalica minor, or radialis externa. This vein in its tract over the extensor radialis, and the supinator longus, has many lateral communications, particularly with the median vein.

This vein, now joined by the median cephalic, and rising upon the outside of the humerus, becomes the great cephalic vein; and it passes, first betwixt the biceps and triceps brachii, and then betwixt the deltoides and pectoralis major muscles. In this course it is joined by several small cutaneous branches, which play over the belly of the biceps muscle, and communicate with the basilic vein; a little below the external condyle of the os humeri, the cephalic vein detaches a branch which ascends betwixt the brachialis internus and supinator longus, and which afterwards forms inosculations with the basilic vein, on the back of the arm.

The great cephalic vein passing up betwixt the tendons of the pectoralis major and the deltoid muscles, sinks into the axilla and joins the axillary vein.

Vena basilica.* We trace the origin of the basilic vein from those veins which, being continued from the plexus, on the back of the hand, take their course over the lower head of the ulna. (A conspicuous branch of these veins, from the little finger, was called

* *Brachialis.* The ancients termed the basilic vein of the right arm, the vein of the liver, or *vena hepatica brachii,* and that of the left, the *vena splenica brachii.*

SALVATELLA * by the ancients.) From this origin, the basilic vein takes a spiral course on the ulnar edge of the fore arm, sometimes in one great trunk, oftener in two, sometimes in a plexus of veins; here it may be called ULNARIS SUPERFICIALIS, or CUBITALIS INTERNA. This vein, now rising before the inner condyle of the humerus, passes on the inner margin of the biceps flexor muscle; here it forms very free and numerous connections with the internal or brachial vein, the satellites and cephalica; still passing up, it sinks by the outside of the tendon of the pectoral muscle, and joins the axillary vein.

The great basilic vein, or the great trunk, after it has ascended above the elbow, and received the median basilic, is joined by several deep branches of veins; as those which accompany the brachial artery, called satellites or comites, and a vein which is called profunda brachii; and still nearer its termination, it receives the addition of the *vena sub-humeralis*, or *articularis*, and the *venæ scapulares*, viz. those answering to the arteries of that name, and coming from under the scapula.

VENA MEDIANA MAJOR. † — This is a vein which runs up the middle of the fore arm, beginning from the plexus of veins, which play over the flexor tendons, and come from the ball of the thumb; it is very irregular, being sometimes double, and sometimes assuming the form of a plexus; often it is particularly short, and can be considered as a trunk, only for a few inches as it approaches the bend of the arm; not unfrequently it is entirely wanting, and, as if annihilated by the greater size of the branches of the cephalic or basilic veins. But, for the most part, when this vein has ascended on the middle of the fore arm, near to the bend of the arm, it divides; one branch passes obliquely outward, and joins the

* *Salvatella quasi Salvator* being opened as a sovereign remedy in Melancholia.

† *Vena media; vena superficialis communis. Fabricii fig. brachii viva.*

cephalic vein; the other inwards and unites with the basilic vein; the first is of course the MEDIAN CEPHALIC VEIN *, the second the MEDIAN BASILIC VEIN.

These are the two branches which the surgeon most commonly selects for bleeding. Around the median cephalic the cutaneous nerves play more profusely, and under the median basilic vein the humeral artery passes. It is by the awkward plunging of the lancet into the median basilic, that the country bleeder sometimes produces the aneurism of the artery; but the dreadful symptoms following the pricking of the nerve, are more frequently produced by bleeding in the median cephalic; cases however occur of the pricking of the nerves, while bleeding in the median basilic vein.

AXILLARY VEIN.—The trunk of the veins of the arm passes through the axilla, until it arrives betwixt the first rib and clavicle, under the name of axillaris. Here lying by the side of the artery, it receives many muscular branches from the flesh of the shoulder, the external and internal scapular veins, and the thoracic veins; in general where it passes by the head of the humerus it receives the cephalic vein.

SUBCLAVIAN VEINS.—The axillary vein continuing its progress over the first rib, becomes the subclavian vein, and is joined by the external jugular vein. It then takes a direction downward, and being joined by the great internal jugular vein, and having received the trunk of the absorbent system just at the angle of the meeting with the great jugular vein, it terminates in the superior cava. On the right side the subclavian vein is shorter, and descends more directly; on the left it is longer, but still its direction is downward and across the upper part of the chest; passing before the trachea and the branches of the arch of the aorta, it joins the subclavian of the right side, and together they form the superior cava. Besides the jugular veins, the left subclavian vein re-

* *Portio cephalica, A. B. loc. cit.*

ceives these : a vein from the shoulder and lower part of the neck ; the vertebral vein ; with some lesser plexus of veins descending from the neck, and the thyroid veins. From below they receive the lesser internal thoracic veins, and the mammariæ. *

## THE SUPERIOR VENA CAVA, THE VENA AZYGOS, AND LESSER VEINS OF THE THORAX.

The superior vena cava is the trunk of all the veins of the head, neck, arms, and of the parts in the thorax ; soon after it is formed by the union of the subclavian veins, it is joined by the vena azygos, and receiving the INTERNAL MAMMARY VEINS, and the VENÆ THYMICÆ and PERICARDIAC, and the INTERCOSTAL and BRONCHIAL veins, it descends into the pericardium, and dilates or opens into the right sinus or auricle.

VENA AZYGOS. † The vena azygos is the principal vein of the thorax, and chiefly of the walls of the thorax. It is observed to take its origin upon the vertebræ of the loins from some of the lumbar veins, or by inosculations with the renal, spermatic, or lesser branches of the abdominal cava, receiving the first and second lumbar veins, as in its ascent in the thorax, it receives the intercostal veins on either side ‡ ; ascending betwixt the crura of the diaphragm, and by the side of the aorta, it sometimes receives the lower phrenic veins. In the thorax lying on the right side of the bodies of the vertebræ, and before the intercostal arteries, it receives the bronchial veins from the root of the lungs, and from the trachea it receives the veins of the posterior mediastinum and œsophagus ; through the intercostal veins, it com-

* *Haller, Icon. Anatomic. Corporis humani Fasciculus* III. *tab. arter. Pectoris.*

† *Sine pari.*

‡ We except some of the veins from the interstices of the higher ribs, particularly on the right side, which enter the subclavian vein.

municates with the external and internal mammary veins, and with the venal circles of the spinal marrow.

Upon the third vertebra, the azygos vein separates from the spine, and after forming an arch, and bending round the root of the lungs, it opens into the superior cava, just where it is about to enter the pericardium. And here where it opens into the great vein, it is guarded by a valve.

This vein, however, like most others, has considerable variety, and does not always merit the name of azygos, for sometimes it is double, a division ascending on the left side of the spine, and uniting with the branch of the other side, just as it is about to enter into the superior cava.

Of THE LESSER VEINS IN THE THORAX.—The VENÆ MAMMARIÆ take a course by the side of the internal mammary artery, and require no description. Like the arteries, they spread their branches on the muscles of the belly, and communicate with the diaphragmatic and lumbar and epigastric veins. The left mammary vein terminates in the left subclavian vein, the right in the superior vena cava.

The VENÆ THYMICÆ enter, either into the union of the subclavian veins, or they enter into the guttural veins, or the internal mammary veins.

The PERICARDIAC VEINS gather their branches from the pericardium, from the aorta, trachea, and lymphatic glands; they send down branches by the side of the phrenic nerve, which inosculate with the veins of the diaphragm; they enter the internal mammary vein, or the superior cava, or join the right subclavian near its termination.

The SUPERIOR INTERCOSTAL VEINS.—The right and left intercostal veins differ in their size and distribution; the right is small, and receives only one or two of the upper intercostal veins, which do not enter into the azygos vein. The vein of the left side begins even so low as the interstice of the seventh rib; it receives branches from the veins of the pleura, pericardium, and lungs, (viz. the bronchial veins,) and

from the veins of the œsophagus, and they enter the subclavian veins.

## OF THE VEINS WHICH UNITE TO FORM THE INFERIOR VENA CAVA.

The inferior vena cava receives the veins of the lower extremities, the hypogastric and abdominal veins, and the veins of the viscera of the abdomen; but those of the spleen and the membranous contents of the abdomen, are received by it, only indirectly, and through the circulation of the liver.

## OF THE VEINS OF THE LEG AND THIGH.

We have observed that the veins of the extremities are in two sets; the deep and the superficial. In the leg and thigh, the deep seated veins accompany the arteries, and receive the same name: the cutaneous veins may be included under the name saphena major and minor, and their branches.

SAPHENA MAJOR. * — A large and beautiful plexus of veins is formed on the fore part of the foot, by veins coming from the back of the toes, and outside of the foot. Two principal veins arise from the arch which these form: one takes the course behind the inner ancle, and is the saphena major; the other passes over the outer ancle, and forms the saphena minor.

The great saphena may be traced from the great toe, from the inside of the foot, and behind the ancle: it receives one or two branches from the sole of the foot. Sometimes the principal branch passes behind the lower head of the tibia, sometimes before it, or it forms circles here: a little above the ancle a vein from the middle of the metatarsal arch comes obliquely over the tendon of the tibialis anticus, and joins it.

The saphena, now a considerable trunk, runs up the leg, before the inner margin of the belly of the

* *Saphena magna interna.*

gastrocnemius muscle, and on the inner ridge of the tibia. In this course, it receives numerous cutaneous branches, and backward, over the belly of the muscles, it forms inosculations with the lesser saphena. From the inside of the leg the trunk ascends on the inside of the knee, where it receives several branches, coming round the joint, and over the head of the tibia. Now passing somewhat obliquely, it ascends upon the thigh, and at the same time turns from the inside to the fore part of the thigh. In the thigh the great saphena receives many branches, and is not always a single vein: for sometimes the branches collecting, form a small trunk, which runs collateral to the greater vein; these join in the groin. In all its course the saphena vein is superficial, and lies imbedded in the cutaneous fat; with but a very slight and imperfect aponeurosis inclosing it; while it is external to the proper fascia of the leg and thigh. As it ascends upon the thigh, however, it does not dive suddenly under the fascia; but is gradually enveloped and embraced by the condensed cellular membrane and fascia, until it finally terminates in the crural vein.

When it was more the practice than at present to bleed in the ancle, the saphena major was the vein selected: but as in all the course of the vein, from the great toe to the knee, it is connected with the nerve which bears its name, there are not wanting instances of those bad effects from pricking of this nerve, which not unfrequently follow the bleeding in the arm.

The surgeon has much to do with this long vein of the thigh, since it is more than any other vein subject to dilatation. By costiveness, principally, and straining at stool, the blood of the abdominal vein is pushed back upon the valves of the crural vein. They yield, or what is the same thing, the coats yield; the diameter of the vein is increased; the valves do not reach across the vein; their action is lost; the column of blood is thus extended, and its

pressure increases. The consequence of this is a painful distention of the veins of the thigh and leg.

In consequence of the rapid distention of the veins of the thigh in this manner, I have repeatedly seen suppurations on the thigh, a complaint not described or understood. The more common consequence, however, is a varicose enlargement of the veins of the leg; and accompanying this source of debility in the circulation of the limb, an ulcer near the ancle, and depending on the state of saphena.

Saphena minor.* — This vein arises from the plexus on the outside of the dorsum of the foot: it runs over the outer ancle, and above the fascia, covering the tendons of the peronæi muscles. Here receiving many branches, and forming frequent deep inosculations, it mounts on the outside of the vagina or fascia, which covers the back of the leg, but gradually becoming deeper, it is found under the fascia, on the calf of the leg, and arriving betwixt the hamstring tendons, it sinks into the popliteal hollow, terminating in the popliteal vein.

The lesser saphena vein, like the anterior one, is subject to become varicose; and when we imagine that the varicose state of the limb, and the consequent ulceration, is depending on the long anterior vein, it may be a consequence of the posterior and lesser saphena.

The other veins of the lower extremity which accompany the arteries in their course, need little description.

Anterior tibial veins. — The veins accompanying the anterior tibial artery form many inosculations, and when minutely injected, almost conceal the artery. They are the anterior tibial veins, and only unite into a trunk, where, perforating the interosseous ligament, it joins the popliteal vein.

Posterior tibial veins. — In the sole of the foot we have the external and internal plantar veins, which

* *Vena saphena parva externa.*

uniting into trunks, accompany the artery behind the inner ancle. In its course betwixt the solæus and the tibialis posticus muscles, it cannot be called the posterior tibial vein ; for it is a mere net-work of veins surrounding the posterior tibial artery. It receives, near its termination, a branch called SURALIS, from the gastrocnemii and solæus : it terminates in the popliteal vein.

The VENÆ PERONEÆ, are the venæ comites of the fibular artery, and are two or three in number. All these veins have free inosculations with each other.

The POPLITEAL VEIN. — This vein is formed by the three divisions of deep veins accompanying the arteries of the leg, and the saphena minor. It lies more superficial than the artery, and seems to cling round it. As it ascends, however, it twists round the artery, the artery being nearest the bone — a little above the joint it receives the lesser saphena. It then perforates the tendon of the triceps, comes to the fore part of the thigh, still united to the artery, and lying posterior to it : it is now the CRURAL VEIN. As it ascends it gets from behind the artery, so that in the groin it lies nearer the pubes than the artery does : opposite the trochanter minor it receives the internal and external circumflex veins, and the VENA PROFUNDA FEMORIS. About an inch below Poupart's ligament the crural vein receives the SAPHENA MAJOR, and the small external pubic veins, and finally the veins which descend from the integuments of the belly.

The veins of the lower extremity are very strong in their coats, and indeed equal the arteries in the thickness of their coats : for example, in an amputation, it will not be possible to distinguish the vein from the artery upon the face of the stump, unless by their relative position. These veins do, in fact, sustain a long column of blood, and great pressure consequently ; and so powerful is this pressure, that when a varicose vein bursts in the ancle, some pounds of blood are suddenly lost. A rupture or wound of

a vein in the thigh has an effect like an artery in sending the blood abroad into the limb.

External iliac vein. — The femoral vein lying on the inside of the artery, or nearer the pubes, enters the abdomen under the femoral ligament, and passing by the side of the Psoas muscle becomes the external iliac vein. It receives several lesser veins just within the ligament, particularly the epigastric vein from the muscles of the belly, and the veins accompanying the arteria circumflexa ilii.

Veins of the Pelvis. — The veins of the integuments of the penis join the superficial veins, which are called pudicæ externæ, and fall into the crural vein in the groin. The proper veins of the cavernous body of the penis, and of the spongy body of the urethra, form the vena dorsalis or vena ipsius penis. This is a large vein which runs down betwixt the dorsum of the penis and the ossa pubis. This vein having made good its course into the pelvis, is joined by a large plexus which is around the prostate gland and the vesiculæ seminales in the male. Here, indeed, the veins are so large, and so irregular, as to deserve the name of sinuses. How much blood they contain is known to the lithotomist, since they are cut in that operation. These prostatic veins are joined by the venæ vesicales. These unite to the branches collateral to the pudicæ, finally to the veins returning from the gluteal artery. These form the internal iliac veins or hypogastric vein, ascending from the pelvis, join the external iliac vein coming from the thigh, and form the common iliac vein.

The common iliac veins. — The common iliac vein begins at the sacro-iliac symphysis, and runs up upon the sacrum to join its fellow of the other side opposite to the cartilage, which joins the fourth and fifth vertebræ of the loins.

Vena cava abdominalis. * — A little lower than

* *Vena Cava inferior.*

the bifurcation of the aorta, the right and left common iliac veins unite, and by this union they form the vena cava. This vein ascends upon the right of the aorta. It receives fewer branches than would naturally be imagined, because the veins of the viscera take their course by the vena portæ into the liver. It receives the lumbar veins, four on each side, the spermatic veins, the renal, supra-renal, and phrenic veins. Passing upward, it is received into its appropriate fossa in the liver, and seceding a little from the spine it receives the VENÆ CAVÆ HEPATICÆ, and perforates the diaphragm; entering the pericardium, it expands into the great sinus, or right auricle of the heart. *

RENAL VEINS. † — These veins are less irregular than the arteries of the kidney, which relation of the veins and arteries is uncommon. From the relative situation of the kidneys to the cava, it is evident that the right vein must be short; the left comparatively longer, and taking a course from the kidney over the aorta. ‡

SUPRA-RENAL VEINS. — These little veins are like the arteries in their course. The right one enters sometimes into the vena cava, sometimes into the renal vein. The left sometimes receives the phrenic vein of that side and enters into the renal vein.

SPERMATIC VEINS. — The veins of the testicles return from the minute extremities of the spermatic artery, distributed in the body of the gland and in the epidydimis, one beautiful and tortuous artery may be seen upon the tunica albuginea testis. As these veins reach the cord they become very tortuous, and encircling the convolution of the spermatic artery, form a thick vascular body. They are joined by the vein of the epidydimis as they ascend. The higher

* *Venæ Cavæ lusus. Act. Petrop. tom.* xii. p. 262. *Sandifort Thes.* vol. i. p. 348.

† Emulgent veins.

‡ The Renal veins, however, sometimes vary in their number, the right being double or triple, the left even sometimes in four branches.

these vessels are, the nearer to the ring, the less convoluted they are, which makes the cord of a pyramidal shape. This is most remarkable in brutes; and in them chiefly have these vessels got the name of CORPUS PYRAMIDALE and PAMPINIFORME.*

The spermatic vein before it enters the abdomen, has collected the principal branches and is fortified with valves. These valves, however, sometimes lose their office in consequence of dilatation of the veins, and then comes a very unpleasant varicose swelling of the spermatic cord, which is attended with a gravitating pain, and some degree of weakness of the gland.

The spermatic vein passing the spermatic passage, and forming a very considerable part of the whole cord, enters the abdomen, but still behind the peritonæum. Here coursing round the loins, it gathers branches from the fat of the kidney, the ureter, &c. The right vein is generally double, the left single; the one joins the cava, the other the emulgent vein.

From the point where the crural vein terminates in the external iliac vein up to the heart, there is no valve. This circumstance of there being no valves in the veins within the abdomen, proves that they are useful only, to guard against the effects of external and muscular pressure, and that where the veins are safe against partial pressure they require no valves.

This circumstance of there being no valves on the lower cava and its branches, makes the wounds of these vessels as full of danger as the wounds of the great arteries. I have known a wound of the external iliac vein prove fatal by a gush of blood, as formidable as if it had come from the artery, because it descended unobstructed from the heart.

I must refer to the anatomy of the abdominal viscera, for the description of the peculiarities in the circulation in the liver.

* Pampiniformis, *i. e.* resembling the tendrils of the veins. *Icon. Anatomic. Corporis humani Fasciculus* iii. *tab. Arter. Pectoris.*

It is sufficient that at present I remind the student that the blood of the stomach and spleen, the small and great intestines, does not fall into the cava. The veins from these floating viscera, as they have been sometimes called, form a trunk, which running obliquely across the abdomen, and entering the liver, is called VENA PORTÆ. The VENÆ CAVÆ HEPATICÆ are two large veins which come out of the liver, and which join the vena cava just as it is passing the diaphragm.

## OF THE LYMPHATIC AND LACTEAL SYSTEMS OF VESSELS.

We have understood that the red blood circulates in the body, through the arteries and veins, and that these vessels have a direct communication at their extremities by inosculation; that although these vessels lie parallel to each other, and extend from the heart to the remotest part of the body, yet the blood is said to pass through the circulation, because it is transmitted from the arteries into the veins, and so back to the heart. In this transmission of the blood through continuous tubes, there is in the coats of the vessels an alternation of contraction and relaxation which impels it forward. But besides these arteries and veins carrying the red blood through the body, there are other pellucid vessels, more remote in their connection with what is generally called the circulating system, and which neither receive an impulse from the heart, nor exhibit any sort of pulsation by their proper force.

### OF THE CAPILLARY VESSELS, AND THE PHENOMENA PRESENTED BY THE MICROSCOPE.

The capillary vessels are those extreme branches which are as minute as hairs; but this, though the

literal, is not the general meaning of the term. By capillary vessels is rather understood those branches in which the changes are wrought from the blood, and which are either so minute as not to allow the promiscuous flow of the particles of the blood, or possessed of such a degree of irritability and appetency, as only to allow certain parts of that fluid to be transmitted.

It is proved, that in the living body there is no exudation; but no sooner is the animal dead, than the fluids exude from the vessels, the secretions pass through the coats of those receptacles which formerly contained them, and one part partakes of the colour of another which is contiguous. From this fact, we are led to think that a property exists in the living fibre, which repels the fluids. Admitting this, it is very natural to suppose that the fibres, and more particularly the vessels in the capillary texture of each organ, possess sensibility, which has its relations to the fluids passing through them, or to be secreted from them.

The most beautiful phenomenon may be seen by the aid of the microscope, in the circulation of the blood, that is, the transmission of the blood from the arteries into the veins. When the web betwixt the toes of a frog is submitted to the microscope, the eye at first discovers only a confused motion of particles. But by a steady continuance of the observation, we are soon able to observe the motion of the red particles of the blood. We do not discover the coats of the vessels, but conclude, that they exist from the confined and certain course of the particles which are in motion. We distinguish the arteries by the rapidity of the particles passing through them in *single files*, and pursuing these particles, they are observed to turn suddenly into larger vessels. These vessels, by the number and slower motion, and altered direction of the red globules, are recognized to be the veins. When the animal is disturbed, there is a general acceleration of the motion of the blood in

the small vessels. When the web or membrane is pricked and irritated, (as with salt and Cayenne pepper in solution upon a needle,) the motion of the particles in the arteries is accelerated in a very singular manner; if the excitement to inflammation be continued, the veins are seen to enlarge, and an accumulation of red particles takes place in them by which they are visibly distended. These accumulated particles are urged forward with a difficulty which seems to be occasioned by the attraction of the fluid to the sides of the coats.

It is remarkable, that while we admire this proof of the circulation, we see the influence of the heart's action upon the blood in these minute veins; for at each pulsation of the heart the red globules are sent forward, being stationary, or recoiling during the diastole.

During the disturbance of the circulation of the part by the application of stimulus, there seems to be a certain attraction or cohesiveness betwixt the sides of the vessels and the red globules, which occasions the remora and accumulation of the red globules. The same was the consequence of cutting the vein across, for the blood, instead of flowing from the cut, became arrested in the vessel.

Since we see that in an inflammatory state the pellucid veins transmit red blood, and that this red blood must be supplied by the serous arteries; then it is proved that answering to the pellucid arteries (in their natural state) there are pellucid veins. We acquiesce, therefore, in the opinion that supposes both the arteries and veins to have pellucid capillary branches answering to each other, collateral to the larger and more evident anastomoses of their red extremities. These anastomosing branches of the arteries and veins in which the red blood is seen to circulate, perpetuate the flow of the greater part of the blood back to the heart, while the several secretions are performed in the capillary vessels; but there is no reason to suppose that the fluids sent from the

arteries into these pellucid capillary vessels are all poured out in form of secretions: part returns into the extremities of the circulating veins. The secreted fluids and solids are either carried away by ducts into their receptacles, or thrown out from the body: while those fluids, which are exuded on the cellular membrane and cavities, are re-absorbed by the system of absorbing lymphatics.

We say then, that arteries terminate, first, in red veins, which is proved by the microscope, and by mercurial and other injections; secondly, in glands; thirdly, in cells receiving red blood; fourthly, in lymphatic veins; fifthly, in exhalents, which pour their fluids into the cellular membrane, cavities, joints, &c. and which fluid is taken up by the valvular lymphatic absorbents.

But these absorbent vessels, of which we are now to treat under the division of lymphatics, do also perform a circulation, inasmuch as they convey back to the centre of the system the fluids which have been thrown out from the extremities of the arteries. But as these lymphatic vessels are not continued from the extremities of the arteries as the red veins are, as they imbibe the fluids, which have been thrown out of the other system of vessels; their fluid contents cannot be conveyed through them by the force of the heart and arteries; these vessels must be peculiar in having powers within themselves, first of absorbing and then of propelling their fluid onward to the heart. Neither can they be said to be circulating vessels according to the use of that term, for although they carry the lymph back to the heart, yet the continuity of the vessels is broken; they are not continuous with the extremities of the arteries.

The LACTEALS are vessels which, distributed to the intestines, absorb and convey into the system the milky opaque fluid which is generated in the intestines by the process of digestion.

The common property of absorption in the lymphatics, absorbents, and lacteals, and their being

connected with the same trunk, occasions their being considered as one system of vessels; yet looking upon the general economy of the living body, we find them ministering to very different purposes. The one branch of the system, the lymphatics, convey the waste of the body again into the circulating system. The lacteal vessels, on the contrary, are those vessels which opening upon the inner surface of the intestines, receive into them the nutritious fluids prepared by the organs of digestion, and suited to supply the incessant waste and destruction of the solid and fluid parts of our frame, which have been absorbed and carried away by the lymphatics. Following this simple view, although the absorbent system be commonly divided into the thoracic duct, lymphatics, lacteals, and glandular apparatus attached to them, I shall throw the present section into the division of the lymphatics and of the lacteals.

### OF THE LYMPHATIC SYSTEM IN PARTICULAR.

The lymphatic vessels are tubes whose coats are perfectly pellucid, having a remarkable power of contraction, which causes them to shrink and disappear, so as to render it difficult to demonstrate them. Indeed they are only to be observed by an eye accustomed to make lymphatic injections. They are called LYMPHATICS, or DUCTUS AQUOSI, from their transmitting a fluid colourless as water. When they are distended with their fluids, they show that they possess a very distinct character from the other vessels. They are irregularly distended, knotty, and sometimes like a chain of beads, or little irregular vesicles connected together. This irregularity is owing to their numerous valves, which are semilunar membranes, like those of the veins, hung across their cavities, so as to catch and interrupt the refluent lymph.* They say, in general, that in the space of an inch the lymphatic vessel has three or four pairs

* *Ruyschii Dilucidatio Valvularum.* Vet. Oper. vol. i.

of valves. But this bears no certain proportion; for as these vessels run where they are exposed to occasional compression from the surrounding parts, or bear the weight of a high column of fluid, their valves are more frequent. The lymphatics are improperly called cylindrical tubes, since they are irregular from their valves, their branching, and frequent communications. The coats of the lymphatic vessels are the strongest of any in the body; for although extremely thin and pellucid, they give resistance to distention beyond a certain point, and bear a column of mercury which would burst through the valves of veins, and tear the coats of arteries. If there be a muscular coat, and no one ever denied the muscularity of the lymphatics, then we may reckon three coats: First, the inner coat, which is the continuation of the inner tunic of the veins, as may be observed in the opening of the thoracic duct into the left subclavian and left jugular veins. It is smooth and polished, forms duplicatures or valves, and prevents the transudation of their fluids: it is connected by cellular membranes to the middle coat. Secondly, the muscular or middle coat, which consists chiefly of muscular fibres, which, according to Sheldon, run in every possible direction, though the greater number take the circular direction. And, lastly, the outer coat, which is connected with the general investing cellular membrane. As the inner coat must chiefly form the valves, and as the valves possess a very remarkable power of resisting the column of mercury, I conceive that the inner coat is that on which the strength and resistance to distention of the lymphatics depend, though it has been said that it is to the outer coat that they owe this property. The muscularity of these vessels is rather inferred than proved: it is inferred from the unassisted action which they have to perform in pressing the absorbed fluids onward to the heart. Nevertheless we sometimes see the lymphatics of the lower extremities of

a colour so red, that we may say their muscularity is demonstrable.

The lymphatics seem to possess little elasticity; when they are blown into, they rise with the slightest force, and remain distended, although the passage of the air forward be uninterrupted; whereas had they considerable elasticity, they would contract and disappear. Indeed, when empty, in the dead body they may be rather said to be collapsed than contracted. Although the lymphatics can be distended with the slightest inflations, yet when distended, as we have already observed, they firmly resist further dilatation. This is a quality necessary to their valvular structure, for if they were elastic beyond this degree of dilatation, the calibre of the vessel would be occasionally so enlarged as to render the valves incapable of meeting, and consequently of preventing the retrograde movement of the fluids.

Indeed they appear sometimes to suffer this kind of enlargement or distention, for we occasionally find that the mercury runs backward along the vessels, contrary to the proper course of fluids in them.

## OF THE GLANDS OF THE ABSORBENT SYSTEM.

Every where throughout the human body and viscera, betwixt the extreme branches of the absorbent system and the trunk, glandular bodies are interposed. Though these glands be of various forms they are generally of an oval shape, and they vary in size from the twentieth part of an inch to a full inch in diameter. Sometimes they are segregated, sometimes accumulated and clustered together. The colour of those bodies is various in the several parts of the body: in young animals they are redder, and become pale only with age. They are redder and stronger in the outer parts of the body, as in the thigh, axilla, &c. less so within the abdomen and thorax. 2. The latter will not bear so high a column of mercury as the former. The mesenteric glands

are said to disappear in old age.* They certainly diminish very remarkably.

It would appear that the glands of this system are of more importance to young animals than to adults. In the fœtus and in children, the lacteal and lymphatic glands are exceedingly numerous; but they shrink with old age. In the fœtus, they can be of no very essential use; they are then rather in a state of preparation for the actions necessary in infancy and youth. It is during infancy and youth that they are most liable to disease, and seem more irritable and ready to inflame, especially when they are placed superficially. About the age of fourteen or fifteen this disposition is changed, which is commonly said to proceed from the increased vigour of the constitution, and the change which then takes place on the organs of generation. It is rather to be attributed, however, to the diminution of irritability and activity of the vessels of the glands at this age, for, as we have said, the glands are now smaller and paler. We may further observe, that the lymphatic glands, even in the scrophulous diseases, are seldom primarily affected: they partake of diseased action from an impression on the surface of the body, or from an affection of the intestines, or from the absorption of matter. The structure of these glands has not been satisfactorily investigated. There is at least some obscurity over this subject. Some anatomists have said, that they consisted of the convoluted absorbent vessels; others, that they are of a cellular structure. When they affirm that these cells are totally distinct from the lymphatic vessels, it is not so easy to understand them: for cells communicating with each other, and into which the lymphatic vessels enter, are very much the same with a series of convoluted, varicose, and irregularly dilated vessels. If we could dissect this series of cells, as Haller did the vesiculæ seminales, we should have represented to us the appearance of a convoluted varicose vessel.

* By Ruysch, Morgagni, Haller, Sheldon.

There is a coat of cellular membrane which surrounds the glands. This coat is pervaded by a peculiar fluid, which has given rise to some speculation. It is observed chiefly in young animals, and is for the most part, though not always, white and milky, and in the glands of the lungs it is of a blackish colour. This is the fluid which, having globules in it, was supposed by Mr. Hewson to be the first stage of the formation of the red globules of the blood. It is distinct from the absorbed fluids, and is a secretion from the arteries. Physiologists have not determined the nature or use of this fluid. The arteries and veins which supply the lymphatic glands, differ in their course from those branches which are supplying the common surrounding parts. The artery takes a long circuitous course, and twists and turns before entering into the gland.

At present there seems no better hypothesis to be offered regarding the use of the lymphatic and lacteal glands, than that they serve to check, control, and measure the flow of the absorbed fluids into the mass of the blood: without them it appears to me probable that at one time the lymph, returning from the body, or at another time the chyle, might flow too rapidly, and in a disproportioned quantity, into the veins and heart. But by the check which the glands impose upon this flow, giving a remora, and serving as receptacles of the absorbed fluids, the fluids are poured with a more uniform and constant flow upon the heart.

As to the opinion, that these glands prevent poisons entering into the system, it cannot be sustained. Is it really so? Have they this effect? And the answer must be, No! On the contrary, they seem the first to inflame, and hence to propagate bad action rather than to prevent the contamination of the system.

## ORIGIN OF THE LYMPHATICS, AND OF THE DOCTRINES OF ABSORPTION.

The lymphatics, forming a system of absorbents, we might say, in general, that they take up all the fluids which have been thrown out upon the surfaces of the body. Thus they arise from the pores of the skin; from the surface of the cavities and viscera, which are covered by the pleura and peritonæum; from the cells of the interstitial and adipose membrane; from all the ducts and cavities of the body. This is the use assigned to this system of vessels; but whether they are the only system of absorbents; whether they carry away all the parts of the system, fluids, and solids; whether they absorb the muscles, membranes, bones, tendons, &c. of which the solid body consists, as well as the secreted fluids, is a question requiring examination: for there is much presumed; a great deal of very loose reasoning brought forward in support of lymphatic absorption, — and this much I must say, although I do not object to the doctrine of absorption by lymphatics. We shall first examine the proofs of the lymphatics being the vessels which absorb the fluids of the cavities and surfaces of the body. The animal machine universally partakes of motion. A principal provision for this mobility of parts, is the looseness of the cellular membrane which every where pervades the body, and supports the vessels, and connects the several parts. This interstitial membrane is elastic, and being cellular, to allow of motion, its surface is bedewed with serous exudation. This fluid is perpetually passing from the extremities or sides of the lymphatic arteries or capillaries into the cellular membrane, and upon all the cavities of the body. The fluid extravasated is called serum, and some have supposed that it passes through inorganized pores, an expression that is not very intelligible; but if by this is meant (as has sometimes been explained) "accidental pores" in the sides of the vessels, it is a supposition quite improbable

and unlikely.* The pores or vessels from which this fluid exudes are called exhalent; and their action is no doubt as completely secretion as that which produces the fluids, which in our wisdom we call more perfect secretions.

That the lymphatics take up the fluids thrown out in the cavities of the body, as the abdomen, thorax, pericardium, &c. there is what nearly amounts to an absolute proof in comparing the fluids of those cavities with that contained in the vessels; for by the experiments of Hewson it is found that if the fluid moistening the cavities be collected, it will form a jelly when exposed to the air, as the contents of the lymphatics do. Thus, if a lymphatic vessel be tied up in a living animal, and then opened so as to allow the fluid to flow into a cup, it will form a jelly like the coagulable lymph. † The fluid of cavities alters in animals diseased; sometimes retaining its coagulability, and even acquiring stronger powers; sometimes losing it altogether. But, which is most essential to our present purpose, it has been observed, that whatever change takes place in the fluids of the cavities, the same is found to have taken place in the fluids of the lymphatics.

* Dr. Hunter supported this opinion, (Commentaries, p. 40.) viz. "that the fluids of cavities were collected by transudation, and not thrown out by exhalents;" an opinion which could only have arisen from not correcting the ideas received in making injections in the dead body by the phenomena of the living system. See *Hewson on the Lymphatic System*, chap. viii. where the opinion of inorganical filtering is successfully combated. — See also Cruickshanks.

† But, by disease, the fluids in the cavities and cellular membrane are altered. In dropsy, for example, the fluid of the abdomen loses the property of coagulating on mere exposure; it comes to resemble more the serum of the blood: this were sufficient proof that the collection is not owing merely to the diminished absorption, but that there is a change of action in the vessels of the peritonæum, pleura, pericardium, &c. An inflammatory action of the vessels will throw out a fluid more coagulable, and which in a high degree of action, will form a film of coagulable lymph or even pus on the surface. But in a state the reverse of inflammation, such, for example, as the debility following inflammation, a serous effusion will be poured out having little tendency to coagulate.

But the student naturally asks, How is the lymph taken into the lymphatic vessels? and here it must be confessed, there is too much field for conjecture.

It was thought formerly that the lymphatic arteries terminated in small pellucid veins: these veins carrying only the thinner, and refusing the red part of the blood, were called lymphatics. When the anatomist threw in his minute injection, and saw the coloured fluid return by the red veins, and the colourless fluid return by the lymphatics *, it was held as a sufficient proof of the accuracy of the preconceived notion, and tallied with observations of Leewenhoeck, and the theory of Boerhaave. † When, however, anatomists more carefully examined the state of parts, they found that the lymphatics were not filled, unless the cellular membrane was previously injected by the extravasation of the fluid from the blood-vessels. Finding that this alleged experiment was really no proof of the anastomosis, and direct communication betwixt the extreme arteries and lymphatics, they conceived that it was a proof that these lymphatics took their rise from the cellular interstitial texture. Then injecting with mercury, they found that when the vessels burst, and the column suddenly descended, and the cellular membrane was filled, the mercury was seen to rise in the lymphatics. Following up this, they blew air, or injected various fluids directly into the cellular membrane, and by this means injected the lymphatics. Thus by an error, by an accidental effect of their injection, the minds of Drs. Hunter and Monro were opened to a freer discussion of the received opinions, and approved authorities. Soon, however, it was understood by those conversant with anatomy, that these accidental injections of the lymphatics did not prove the lymphatics to take their origin either from the cells or from the extreme arteries; but already this good effect, at least, was

* It was probably Nuck who first injected the lymphatics from the arteries.

† See introduction to the account of the viscera.

produced, that men's minds were excited to enquire after new facts, and to follow a new train of observation. It was now recollected, that a strict analogy and correspondence subsisted betwixt the lymphatics and lacteals; the proofs of the lacteals being absorbents, were recalled to memory; new proofs of their being the sole absorbents of the intestines were brought forward; the nature of the fluids effused into the various cavities and cells of the body was attended to; and the conviction followed, that the most essential use of the lymphatic vessels was to serve as a system of absorbents, to take up the fluids extravasated, or, secreted on the surfaces of membranes and cavities.

An additional proof of lymphatic absorption has been derived from the manner in which the venereal virus is received into the system. Venereal matter being allowed to lodge upon the delicate skin of the glans penis or preputium, causes an ulcer there. The matter of this ulcer is absorbed by the lymphatic of the part; an inflamed line is sometimes to be traced into the groin; and the lymphatic gland of the groin, receiving this absorbed matter, inflames and forms the bubo. Here, then, is a proof that the red veins do not absorb, and that lymphatics do: else why are they inflamed?—and why are the lymphatic glands inflamed to suppuration.

We must observe, however, that there is here by no means an absolute proof of absorption of venereal matter. Although we believe in the general system, we may hazard these queries: If this matter be absorbed, why is there no infection without ulcer (chancre) of the glans? If this ulcer be produced by absorption, how comes it that the constitution is not infected by the first absorption of the matter, and before it has formed an ulcer? Is it not probable that the irritation of the venereal matter, lodging on this vascular surface, and without being absorbed, causes a peculiar inflammation, the tendency of which is to form a pustule, and to produce matter similar to that

which originally infected the part with the specific and peculiar action? Again it will be said, however the venereal pustule was originally produced, it appears evident that the absorption of this matter, the conveying of it along the lymphatic, inflames the vessel, and the next lymphatic gland into which it enters, receiving the venereal matter, inflames and suppurates, &c. But again, I choose to say, with every show of likelihood, that neither is this a proof of absorption; but that the lymphatic vessel being very irritable, and always receiving its stimulus to action from its extremities, it has partaken of the venereal inflammation: that this inflammation has been propagated to the gland; that, the gland being formed of the convoluted lymphatic vessels, the effect of this inflammatory action is there accumulated to so great a degree as to lead to suppuration. If a bubo in the groin were a consequence of absorption, to injure and inflame the mouth of the lymphatic, would be the method to prevent it. But, on the contrary, to irritate a chancre, is the means of producing bubo. If a chancre be indolent, although matter be formed in it, no bubo will be produced; but if the surgeon applies some corrosive dressing, which, instead of entirely destroying the diseased spot, inflames it, then will the gland in the groin sympathize and rise into a bubo. And further, that the disease is received into the constitution only in consequence of the system at large partaking of the irritation (a word which but imperfectly expresses the change) of the local action of vessels. Matter might be absorbed and taken into the constitution, and the disease propagated according to the common explanation; but, according to that offered here, there must be a primary and local disease, from which the general affection is propagated. If we are to take the inflammation and hardening of the lymphatics and axillary glands as a symptom of absorption from a diseased mamma, we must acknowledge the same proof in evidence of the veins absorbing. The lym-

phatics are more active, and their activity depending on the state of their origins and extreme branches, they are more liable to inflammation than the veins; yet are the veins affected in a way that would, on this proof being admitted, prove them to be absorbents. We see how they enlarge around a diseased breast, become prominent and hard, and lose their softness and elasticity; how they show themselves on the surface of a white swelling, or on a cancerous tumour. But, as we would not say that this is a proof of absorption by the veins, neither is the proof unequivocal that there is absorption by the lymphatics. Again, a suppurating stump, with bad inflammation, will cause inflammation of the lymphatics, and suppuration in the glands of the groin*; a proof of absorption of the matter of the stump; but do we not find that from such a stump the veins ascend, inflamed and suppurating, while sometimes a chain of abscesses is formed for a considerable extent? This, we can have no doubt, is the effect of the inflammation continued along the vessel; and is not the inflammation produced precisely in the same way in the lymphatic?

I found my opinion of the lymphatics being absorbents, — first, on the circumstance that their structure is adapted to this action; secondly, on the analogy between them and the lacteals, in which absorption is proved; thirdly and lastly, upon their continuing to receive and transmit their fluids, after the heart and arteries have ceased to beat, and the red blood to circulate: for then how can they act, but by their own powers? How can they receive fluids but by absorption? Finally, they exhibit a greater degree of irritability, and stronger principle of activity and tenacity of life, than the vessels which carry red blood.

* See Hunter's Commentaries.

## OF THE ABSORPTION OF SOLIDS.

On examining the works which within the last fifty years have contributed to throw light on this subject, we are forced to acknowledge how necessary it is for that part of a systematic book of anatomy, which professes to treat of absorption, to take the form of a critical enquiry. When the absorption of the fluids in the cellular substance, or contained in the cavities, was universally assented to, physiologists did not make sufficient distinction betwixt the absorption of this fluid thrown out of the influence of the circulating vessels, and that matter which continued to be involved in the membranes and vessels, and which formed the solid part of our frame. It will readily be allowed, that the fluid thrown out upon the surfaces of the body and in the cells, might be absorbed without inferring that every part of the body, solids and fluids, were also taken up by the lymphatic absorbent vessels. But physiologists observing that the solid parts of the body were suffering perpetual change, that the whole body and the vessels themselves were formed, decomposed, and carried away, they hesitated not to attribute this to the deposition from the arteries, and the absorption by the lymphatics. This alternate destruction and renovation of parts, the perpetual change which the whole body suffers, has been universally acknowledged to be the operation of the lymphatic system, without any other proof than what is offered by a slight analogy.

There is proof that the interstitial fluids, and the fluid in the cavities, are imbibed by the absorbing mouths of the lymphatics on the surface of the membranes; but where is the similarity between this and the destruction of solid parts? It has been said that the absorbents eat down the solids, and nibble like the mouth of a worm! a mere conjecture, and most improbable. The solids are raised by the agency of the vessels on the chemical affinities of the circulating

fluids. They must be resolved by a process, reducing them again to the state of fluids; or the secreting vessels throw out fluids which dissolve them; there must be an operation anterior to their absorption. From the comparative simplicity of the fluids of the circulating vessels, and in the absorbents, with the various compounds forming the solid and fluid mass of the body, we are authorised to conclude, that as from the blood the several secretions, solids, and fluids are formed; these fluids, before they are again taken into the active system of vessels, are resolved into their original simple and constituent parts. We are not then to look for the matter of the component parts of the body in the absorbing system of vessels more than in the blood, from which these parts were originally formed; nor are we at liberty to suppose that they are taken down by a process like eating or abrasion. I conceive that the absorption of the solids depends but in a certain degree on the agency of the absorbents; and that there must be a change in the aggregation of the matter previous to the absorption.

Mr. Hunter says that his conception of the matter is, that nature leaves little to chance; and that the whole operation of absorption is performed by an action in the mouths of the absorbents. Physiologists have laboured, he observes, to explain absorption on the principle of capillary attraction, because it was familiar; but as they were still under the necessity of supposing action in the vessels after the matter was absorbed, they might as well have carried this action to the mouths of these vessels.

We are surprised at the extravagant conclusion to which this idea has led Mr. Hunter. He proceeds to consider the many kinds of solids the lymphatics have to carry away, and the variety of mouths in different animals, suited to the great variety of substances they have to work upon, and then draws the conclusion, or leaves his reader to do so, — that not only are the mouths of the lymphatics calculated to absorb fluids; not only do they carry away the solids,

but each vessel, according to the hardness and toughness of the material upon which it has to operate, has a mouth adapted for the work.

He admits that oil, fat, and earth of bones, had always been considered as subject to absorption; and that some other parts of the body, liable to waste, had been supposed to suffer by absorption; but that any solid part should be absorbed, he supposes to be entirely a new doctrine. Now, I think we may venture to affirm, that not only was it known that solid parts of the body were taken away during life; but that physiologists knew that every part of the living body was undergoing a perpetual decay and renovation. Nay, we may venture further to say, that Mr. Hunter did not comprehend, in its full extent, the relation in which the secreting and absorbing vessels stand to each other. He is fond of calling the absorbents modellers, — "modellers of the original construction of the body," — "modellers of the form of the body while growing."

Mr. Hunter could contemplate no change in the body during growth, decay, or disease, where there was an alteration of form or quantity of matter, without attributing it to the "modelling absorption." A bone cannot be removed without absorption; nor a part which is useless to the economy (as the alveoli of the teeth, the ductus arteriosus, the membrana pupillaris, the thymus gland,) diminished in size or totally carried away, without the absorbents being in action. This, he continues, is the only animal power capable of producing such effects; and like all other operations of the machine, it arises from *stimulus* or irritation, &c. On the contrary, I conceive that the absorption of parts in the natural action of health or in disease, is not owing to increased stimulus, but often to a diminution of it.

Does it not strike us forcibly, that when a gland swells, and leeches and blisters are applied, and it subsides, this can be no means of exciting absorption; that when pressure is made on a part, and that part

is absorbed, this is a strange way of stimulating? Or, when we bleed, is it not odd that this should give new power to the lymphatic system? For these are the means of giving a counter irritation, and of suppressing action.

According to Mr. Hunter's ideas, the lymphatics do nothing without forethought and intention: when they absorb, it is because they have found the parts useless in the economy. He has carried this notion so far, that he does not only speak of the absorption of the thymus gland, membrana pupillaris, alveoli of the teeth, &c.; but of the body in fever as a consequence of its becoming useless when under disease! — The following may perhaps appear to be the more natural supposition.

In a living body we may observe the agency of the nervous, vascular, and absorbing systems: and the phenomena of life are not to be attributed to any one, but to the whole of these. We must also observe, that life, or the mutual action of parts producing the phenomena of life, is proceeding from excitement, and as in the whole system, so in the individual parts of the body, the healthy action depends on the influence of this excitement to action. The tendency of the growth of the body to peculiar forms, and the increase of parts in disease are produced by it. It acts upon the vascular system in disease, by producing increased action and secretion; as a muscle, in the use of frequent and strong action, will become more fleshy and vascular; as a gland will be excited to greater action and more profuse discharge, whilst it enlarges and swells up. When a part enlarges in consequence of the stimulus to increased action, whether arising from the natural law of the constitution, or from disease, it proceeds from the secreting vessels preponderating over the absorbent vessels. There is a deposition of matter which the latter are unable to take away. But diminish this action of the arteries, or take away their excitement, or cause an excitement of some neighbouring part,

and thereby subdue their action, relieve them of their fulness, and the absorbents regain their proportioned actions, and the swelling subsides. The parts of the body which, in the natural changes from youth to age, are absorbed and carried away, are those in which there is no longer the stimulus to vigorous action, and of course the lymphatics overcome the power of the secreting vessels, and the part gradually diminishes, loses its apparent vascularity, loses its redness, and is at last totally absorbed. And as the tooth of a child after lying long hid under the jaw, when it partakes of the stimulus to the action of its vessels, grows, and rises up, and the alveoli, partaking of this natural excitement also, form around it; so, when the tooth decays and falls out, the alveoli will also decay and be absorbed; because the moment these vessels have ceased to partake of the increased action, their absorbents, though acting with no greater powers than formerly, do yet so preponderate, that a gradual wasting is the consequence. Thus we have to consider, not the action of the absorbents merely, but the relations which their actions have to activity of the arteries.

I should conclude, that a part which has ceased to be of use in the economy, and is absorbed, has not been carried away by the stimulus applied to the modelling lymphatics, but in consequence of a want of the usual excitement of the arteries to action by a decrease of their action, and consequent deficiency of secretion. Since, in the natural body, every part holds its due form and proportionate size, by the balance established betwixt secretion and absorption, we have to decide whether its disappearance be an effect of the diminution of the former, or the increase of the latter action. We have to enquire whether the arterial system which secretes, or the lymphatics which absorb, are the most subject to influence. Now, when we see the pulsation of the arteries, and the colour and degree of vascularity of parts, continually varying upon the excitement: when, on

the other hand, we see the lymphatics continuing their office unimpaired even after the death of the general system, and after the heart and arteries have ceased to move, we cannot be at a loss to determine which system of vessels is most subject to influence. Let us only suppose that the lymphatics are more permanent in their activity, least subject to change, and all difficulty is removed. Then we see how stimulating the arteries increases the growth, and how fluids are poured out in swellings, and how, by diminishing their activity at any time, the lymphatics, merely by the continuation of their usual action, produce an absorption and evident wasting.

Before we speak so familiarly as we do of stimulating the lymphatics, we ought to prove that it is possible to stimulate to absorption, in the same way in which we can demonstrate the effect of stimulus upon the arteries; and we should in the next place prove, that it is possible to stimulate the lymphatics, without influencing the arterial system in a similar degree.

We speak very commonly of stimulating the lymphatics to absorb by mercury; for example: — There may be a speck on the cornea, and calomel, or corrosive sublimate is given to excite absorption. The practice is good, but surely this is the language of an erroneous theory. Suppose that we were rather to say, an inflammation from general disorder of the system, or of the viscera, has taken place, where it is most of all likely to take place; a course of mercury corrects this disposition; the cause removed, the inflammation subsides, and with it the speck. The same argument suits the phenomenon when a tumour or enlargement of a viscus is diminished, better than to say, that the mercury excites the lymphatics to the absorption of the tumour.

As to pressure causing absorption and producing the wasting of parts, I cannot agree with Mr. Hunter in supposing that the lymphatics are here excited to action; but should rather infer that the nerves of

the parts being benumbed, and the action of the arteries diminished, the lymphatics continue to do their office, while the arteries are prevented from depositing new matter.—For example, when we see a curvature of the spine, from a habitual inclination of the body to one side, and consequently greater pressure on the one side of the bodies of the vertebræ, it is natural, at first sight, to say, since the one side of the vertebræ is of its natural depth, and the other diminished, that the side which is deep has remained, but the other side has been absorbed; but, when we inquire further into the phenomenon which has taken place, we recollect that the matter of bone is undergoing a perpetual change, and that the matter of both sides of the vertebra is changed; we then comprehend that the pressure may not have excited the vessels to greater action so as to cause absorption, but that the pressure has prevented the deposition of new matter, when the old was taken away in the natural routine of the system.

Mr. Hunter has assigned five causes of absorption, which I conceive may be very naturally resolved into one.—These are, 1. parts being pressed; 2. parts being irritated; 3. parts being weakened; 4. parts being rendered useless; 5. parts becoming dead. Of the first we have already spoken. The second I should deny, unless when it resolves into the third; for irritation does not cause absorption, unless when it is to an extent sufficient to destroy the natural action and weaken the part. The third and fourth come under the effect of the loss of the natural and accustomed stimulus to action in the arterial system, which of course gives the balance in favour of the absorbents. Of the fifth we can have nothing to add illustrative of the living system.

A question is still undetermined; Do the lymphatics absorb the loose or free fluids secreted on the surfaces? Do they always take up what is offered to their mouths, in the manner that we know they do extravasated blood or bile? And is it the office of

the veins to return the matter, which formed that part of the texture of animal bodies, which was never separated from the influence of the circulating system? What is this carbon, for example, which forms the distinction betwixt the venous blood and the arterial? Is not this carbon the waste of the animal frame returned by the veins, and is not this process of the nature of absorption? In short, there appears to me still an open field for enquiry, where an ingenious man may gain in future as much reputation as Dr. Hunter and Dr. Monro acquired by their investigations into lymphatic absorption.

## OF THE COURSE OF THE LYMPHATICS.

The lymphatics, in their course and relation to the fascia and muscles of the extremities, bear a great analogy to the veins; for there are two sets or grand divisions,—the DEEP LYMPHATICS which accompany the arteries in their branchings amongst the muscles; and the SUPERFICIAL set which run a course external to the fascia.

OF THE FOOT, LEG, AND THIGH.—Even in the toes the same distinction of the origins of the lymphatics may be observed, as in the limb. For while a plexus covers the toes superficially, and runs up upon the foot with the veins, deeper branches accompany the arteries on the side of the toes. When we observe the course and origins of the greater and lesser saphena vein, we cannot fail to understand the course of the several sets or divisions of the lymphatics of the foot and legs.

From the toes, dorsum, and edges of the foot, the lymphatics climb up the leg in four classes. 1. One takes a course from the root of the great toe and inside of the foot, over the tendons of the great toe and tibialis anticus tendon. It then passes on the inside of the tendon of the tibialis anticus muscle, and before the head of the tibia, following the principal branch of the great saphena vein; and then

continues its course in company with the saphena to the inside of the knee. 2. There is at the same time a considerable number of lymphatics, taking their origin from nearly the same place, viz. the inside of the foot, and before the inner ancle; but they take a different course on the leg from the last class; for they pass behind the lower head of the tibia: they attach themselves to some branch of the saphena vein, and join the former set of vessels on the inside of the knee. From this they ascend superficially above the fascia to the glands of the groin. 3. From the outside of the foot there ascend several lymphatics; a division of which passes before the outer ancle and across the tibia to join the lymphatics, parasites of the great saphena vein, and here they sometimes form plexuses and contortions; others turn in behind the outer ancle, and join the branches accompanying the lesser saphena vein.

The lymphatics which turn round behind the outer ancle pass on the outside of the tendo Achillis; and accompanying the lesser saphena vein, sink into the popliteal hollow. Here they unite with the lymphatics which have accompanied the several arteries of the leg and foot, and particularly the posterior tibial artery.

The deep lymphatics accompany the arteries, as we have said; and to inject them we should look for a very large vessel which is coming out from under the plantar aponeurosis to rise behind the inner ancle.

Popliteal glands.—The glands of the ham-string cavity are generally three in number, and very small. They receive some of the lymphatics, which pass with the posterior tibial artery and with the lesser saphena, but they are most apt to be disturbed and to swell when the interior of the knee joint and bones are affected. They are very seldom diseased, which I attribute to their deep situation.

From the popliteal glands there ascend two large lymphatics, which accompany the popliteal artery and venæ comites, and ascend with the latter through

the adductor magnus to the fore part of the thigh. They run irregularly, or form a kind of net-work round the great vessels. On the fore part of the thigh, and still deep, they enter the lower and deep inguinal glands.

Sometimes these deep lymphatics, instead of being accumulated into larger trunks, divide into many branches, and only unite in the glands of the groin.

Inguinal glands. — The inguinal glands are in number from five to ten; they lie involved in cellular membrane on the outside of the femoral ligament. Some of them are superficial and moveable under the integuments; some involved in the laminæ of the fascia, which descend from the abdominal muscles; some are close on the femoral artery and vein, and under the fascia. Nearer to the pubes may be observed a division of these glands which belong to the lymphatics of the penis, perineum, &c.

The greater cluster of glands on the top of the thigh becomes affected from disease of the integuments on the fore part and inside of the thigh and leg; and of that part of the foot where the great saphena vein commences; these inguinal glands swell also from sores of the buttocks, about the anus and private parts. And this is a very common source of error. Many times I have seen a patient under mercury for a supposed bubo of venereal origin, when the real cause was irritation at the verge of the anus.

Lymphatics of the parts of generation in both sexes. — From the penis there run backwards two sets of lymphatics: superficial ones, which take a course to the groin; and deeper ones, which take a course along the arteries of the penis into the pelvis, or under the arch of the pubis. The superficial lymphatics are the cutaneous vessels, and take their origin from the prepuce, and it is these which, either absorbing the venereal matter of chancre, or sympathizing with the venereal action, form sometimes an inflamed line along the penis and cause the bubo in the groin. But as there are two sets of lymphatics,

the chancre may be in a place where the deep-seated vessels are the absorbents, and consequently the constitution may be contaminated without any bubo in the groin; and indeed it has been observed, that a venereal ulcer of the prepuce will, in general, produce bubo, when an ulcer of the glans will not. * When the tract of the matter is through the deep lymphatics which enter the pelvis from below, the gland through which the vessels pass, is not inflamed to form a bubo; neither do the lymphatic glands within the ligament of the thigh inflame to the extent of forming a bubo, either from chancre or from bubo in the groin. This, says the celebrated Mr. Cruickshanks, is very fortunate; for if the external iliac glands, like the inguinal glands, should suppurate, they could not be opened by the lancet, they must be left to themselves; they might burst; the pus might fall into the cavity of the abdomen; might produce peritonæal inflammation; and might probably destroy the patient. Now, there appears no reason to dread any such catastrophe. The matter of these glands would form an abscess, which, like other abscesses in the tract of these vessels, would fall down upon the thigh. The fact, however, is curious; that when the inflamed lymphatic enters one set of glands, there will be no bubo; when it takes a course to the other, the gland inflames and suppurates. This I believe may be explained, on considering the position of the inguinal glands, as being immediately under the skin: for experience shows that a part near the surface will inflame and proceed to suppuration much more readily than a part deep-seated, though suffering from the same degree of excitement.

A foreign body, if lying deep, will cause no suppuration or distress; but if it be under the skin and superficial, inflammation and suppuration will be the inevitable and immediate consequences. This may

* Cruickshanks, p. 138.

serve to explain why the two glands equally irritated, may be affected differently, and why it is the superficial one that inflames. And here it may be well to notice, that the suppuration which attends these inflamed glands is not in the body of the gland, but in the surrounding cellular membrane.

In the external parts of a woman (by Mr. Cruickshank's observation) there are also two sets of lymphatics. Those near the clitoris pass up in a direction to the ring; and those from the lower part of the vulva and perineum to the glands of the groin.

LYMPHATICS AND GLANDS WITHIN THE LIGAMENT OF THE THIGH. — The vasa efferentia of the inguinal glands are in number from two to six. The deep lymphatics which accompany the femoral vein and artery, lying under the cellular membrane, pass under the ligament, and soon form a large net-work of vessels accompanying the iliac vessels, and here they are joined by the branches of lymphatics from the superficial glands; sometimes the trunks, accompanying the great vessels of the thigh, pass into a gland immediately within the ligament; sometimes one or two of them only enter into the glands high in the loins; nay, sometimes a large vessel passes on directly to the thoracic duct.

From six to eight or ten glands are seated in the tract of the external iliac vessels, under the name of EXTERNAL ILIAC GLANDS. And upon the inside of the brim of the pelvis, and on the hypogastric vessels, the glands are called the INTERNAL ILIAC GLANDS. In proportion to the frequency of disease in the pelvis, these external iliac glands, being in the tract of the lymphatics of the private parts and rectum, &c. are particularly subject to disease. Those glands also which are called SACRAL GLANDS, as lying on the mesorectum, and in the hollow of the sacrum, have been observed to be often diseased. On the psoas muscle, and on the loins it is impossible to trace the vessels as single trunks; we may observe that one net-work of vessels ascends upon each psoas muscle from the thigh;

and it is there joined by the lymphatics of the pelvis. These vessels are in a manner united to those which cover the prominency of the sacrum, and pass under the bifurcation of the aorta. The two GREAT LUMBAR plexuses of the lymphatics continuing their ascent, many of the vessels enter into the lumbar glands; and on the loins they are joined by the absorbents of the testicle. By the union of the lymphatics ascending from the right and left side, with several large trunks of the lacteals from the root of the mesentery, the thoracic duct is formed on the third and fourth vertebræ of the loins.

### OF THE LYMPHATICS OF THE ARM.

In the arm, as in the leg and thigh, there are two sets of lymphatics: — the superficial and the deep-seated. The first of these accompany the cutaneous veins, the latter the deep arteries.

As in general there are two great veins on the fore arm, the basilic and cephalic veins; but particularly as the veins which gather into the basilic trunk, on the inner and lower edge of the fore-arm, are the larger and more numerous class; so it is found that the course of the more numerous class of lymphatics is on the lower and inner side of the fore-arm, and that they accumulate about the basilic vein. These are derived from the palm of the hand, and from the ulnar edge of the hand. This set sometimes passes into glands, seated on the brachial artery, near the inner condyle of the humerus.

The absorbents which accompany the cephalic vein arise from the side of the thumb and fore finger upon the back of the hand; they run on the radial edge of the arm, with the veins which ascend to form the cephalic vein. From the bend of the arm these vessels take a course on the outer edge of the biceps, and then get betwixt the inner edge of the deltoid, and outer edge of the pectoral muscles; they then pass under the clavicle, and descend into the axillary

glands. This set of absorbents receives the branches from the outside of the arm in their whole course.

There are absorbents arising from the back of the hand, next the little finger, which following some of the branches of the basilic vein (a larger branch of which is called the ulnaris externa) turn round the ulnar edge of the arm, are inserted into a gland, very commonly found before and a little above the inner condyle of the humerus. From this gland a large lymphatic passes upwards, and attaching itself to the brachial artery, splits and plays around it.

The deep-seated lymphatics of the arm accompany the arteries in the same manner as the venæ comites do; in general two with each artery. They all terminate in the glands of the axilla, and can require no particular description. The lymphatics, from the muscles and integuments on the back of the shoulder, also turn round and enter into the glands of the axilla.

The GLANDS OF THE ARM are small, and irregularly placed in the course of the humeral artery, from the condyle to the axilla. They are from three to six in number.

The GLANDS OF THE AXILLA are large and numerous; they receive the lymphatics from the arm, breast, and shoulder*; they lie in the deep cavity of the axilla, formed by the tendons of the pectoralis major, and latissimus dorsi muscles. They are imbedded in a loose cellular membrane, which, while it surrounds and supports the vessels of the axilla in the motions of the joint, gives them strength from its elasticity. These glands do not all surround the axillary artery; but a lower cluster is attached to the branches of the subscapular artery, going forward on the side of the chest, and to the thoracic arteries. These are the glands which become indurated from cancer of the breast. The glands of the axilla when

* "They even receive absorbents from the cavity of the chest, and I have known them swell from the pleurisy, peripneumony, and pulmonary consumption."—Cruickshanks.

greatly enlarged, close upon the artery and plexus of nerves, so as to preclude the possibility of an operation; they compress the veins and benumb the arm by pressure upon the nerves. When they suppurate, even from causes less formidable, and in scrofulous patients, they sometimes produce a condensation of the cellular membrane in the axillary cavity, which, involving the nerves of the arm, produces weakness and shrinking of the arm.

When a wound or puncture, such as that which the student of anatomy may receive in the dissecting room, has been made on the little or ring finger, the red lines which often appear in consequence of it, have taken the course of the ulnar edge of the fore arm, and terminate in the inside of the arm, near the condyle; in instances they have been continued into the axilla. If venereal matter be absorbed at any part of the hand, near the little or ring finger, or by a sore on those fingers, the gland at the inner condyle of the humerus, or some one in the course of the brachial artery, will most probably inflame and form a bubo, and the surgeon will be aware of this absorption; but if the venereal matter be absorbed on the thumb or fore finger, it is possible that it may not pass into the glands until it comes into the inside of the clavicle. These glands being out of our sight and feeling, the patient may be infected without the surgeon suspecting it. *

### LYMPHATICS OF THE HEAD AND NECK.

Of the absorbents of the brain, little is known precisely; but none can deny the probability, that the arteries, veins, and lymphatics bear the same relations in the brain as in the other parts of the system. Lymphatic glands are observed in the course of the internal jugular vein, and even in the foramen caroticum, which are understood to belong to the lymphatics of the brain. The lymphatics of the head are

* Cruickshanks, p. 182.

to be observed in the course of the temporal and occipital arteries; the latter class terminate in glands, seated behind the mastoid process of the temporal bone. The lymphatics of the face have been observed to be very numerous, accompanying the facial and temporal arteries. But those from the internal parts of the face and nose accompany the internal maxillary artery, and fall into the glands under the parotid, or in the course of that artery. These glands are liable to disease, from absorption of the matter of abscess in the face, throat, and nose. The lymphatics from the gums and jaws accompany the internal maxillary artery, and emerge under the angle of the jaw; and some of them joining the external jugular vein, pass through glands near the top of the shoulder. The lymphatic vessels from the tongue and parts about the os hyoides, take also the same course. To know the GLANDS about the FACE and JAWS is of the greatest importance to the surgeon. When brought to a child with a diseased lymphatic gland in the neck, they should not, as I have seen too many do, immediately declare the child scrofulous. They ought to consider the place of the gland and the lymphatic vessels that belong to it, and the part from which that lymphatic comes. By this they will in all probability be directed to some local irritation. There is an inflammation and discharge from behind the ear, and it has produced a swelling of the gland seated below the lobe of the ear. Or the swelling is anterior to the ear, and has proceeded from some irritation in the eyelid or nostril. Or it is a swelling of that gland which is situated upon the facial artery, just under the angle of the jaw, and has come from some excoriation of the lips. Or it is a swelling of some of the glands on the side of the neck, and may have come from some excoriation at the roots of the hair. Or it is more forward and deeper, and then in all probability it has come from some inflammation of the throat.

There are in general several small lymphatic glands, on the side of the face, on the buccinator muscle, immersed in the surface of the parotid gland, and under the zygomatic process. There are also glands to be carefully noted, which lie under the tip of the parotid gland, where it extends behind the angle of the jaw, and also lying under the base of the jaw-bone, close to the sub-maxillary gland, and on the course of the facial artery.

The GLANDS and ABSORBENTS of the neck are very numerous, and the latter form an intricate and beautiful plexus, several branches of which are to be observed accompanying the external and internal jugular veins. Some of the glands lie immediately under the skin, and in the cellular membrane, on the outer edge of the platisma myoides; many under that muscle, and in the course of the external jugular vein. But there are many seated deep, for the greater number accompany the internal carotid artery, and internal jugular vein, or their branches.

The lymphatics of the THYROID GLAND have been raised by Mr. Cruickshanks, by plunging a lancet at random into the substance of the gland, and blowing into it, or throwing quicksilver into its cellular membrane. The trunks of these lymphatics join the thoracic duct on the left side; and on the right side, the right trunk of the absorbing system, just as it is about to enter into the jugular vein.

## OF THE TRUNKS OF THE ABSORBENT SYSTEM.

The larger and proper trunk of the lymphatic system is generally called the THORACIC DUCT, because it was first observed by Pecquet * to be a vessel which conveyed the chyle through the diaphragm, and which took its course through the whole length of the thorax, to discharge its fluids into the veins near the heart. Before his time the lacteals which

* In the year 1651.

were discovered by Asellius *, were supposed to terminate in the liver. The first discoverers of the thoracic duct, described it as beginning from a pyriform bag, to which they gave the name of RECEPTACULUM CHYLI. In dogs, fish, and the turtle, such a cistern or bag may be observed ; but in the human body nothing further is to be observed than an irregular dilatation of this vessel, like a varicose distention, where it receives the accession of the lacteals from the root of the mesentery. The origin of this great trunk called the thoracic duct, is the union of the vessels which ascend by the side of the common iliac arteries and veins, and are derived from the pelvis and lower extremities. Upon the third and fourth vertebræ, and under the aorta, this trunk is frequently joined by a large trunk of the lacteals, and then ascending, it receives the greater number, or the larger trunks of the lacteals. On the vertebræ of the loins, the thoracic duct is by no means regular, either in its course, or size, or shape ; often it contracts, and again irregularly dilates, as it seems to emerge from under the aorta. On the uppermost vertebra of the loins, the thoracic duct lies betwixt the right crus of the diaphragm and the aorta. From this point it runs up on the face of the dorsal vertebra, and betwixt the vena azygos and the aorta. On the fourth dorsal vertebra it passes under the aorta to gain the left side of it. Here it is considerably enlarged, from the contracted state which it assumes in the thorax. Sometimes it splits, and again unites on the vertebræ of the back. Still ascending, it continues to incline to the left side, and may be found by the side of the œsophagus.

The thoracic duct now emerges from the thorax, and lies deep in the lower part of the neck, behind the lower thyroid artery, and on the longus colli muscle.

* In the year 1622. — About the year 1652, the other branches of the system, which take their course to every part of the body, were discovered by Rudbeck, Jolyffe, and Thom. Bartholin.

It gets above the level of the subclavian vein of the left side, and here it receives the absorbents of the head and neck (of the left side), and descends again with a curve, and terminates in the angle of the union of the subclavian vein and jugular vein of the left side.

Sometimes there are two thoracic ducts; but this is very rare. Sometimes the duct splits near its termination, and the two branches enter the veins separately; but, in general, when it splits in this manner, it again unites before it terminates in the vein.

There is constantly a trunk in the anterior mediastinum under the sternum, almost as large as the thoracic duct itself, which is sometimes inserted into the termination of the thoracic duct; sometimes into the trunk of the absorbents of the left side, to be immediately described.

### THE TRUNK OF THE ABSORBENTS OF THE RIGHT SIDE.

The absorbents, from the right side of the head and neck, and from the right arm, do not run across the neck, to unite with the great trunk of the system; they have an opportunity of dropping their contents into the angle betwixt the right subclavian and the right jugular vein. These vessels then uniting, form a trunk which is little more than an inch, nay, sometimes not a quarter of an inch in length, but which has nearly as great a diameter as the proper trunk of the left side.

The trunk of the left side lies upon the subclavian vein, and receives a very considerable number of lymphatic vessels: not only does it receive the lymphatics, from the right side of the head, thyroid gland, neck, &c. and the lymphatics of the arm; but it receives also those from the right side of the thorax and diaphragm, from the lungs of this side, and from the parts supplied by the mammary artery. Both in this and in the great trunk there are many valves.

## OF THE LACTEALS AND LYMPHATICS OF THE INTESTINAL CANAL.

We shall afterwards have to observe the great length of the intestinal canal, the effect of the imperfect valvular structure, in extending the inner coat to a great length; we have remarked that while every surface of the body secretes, it is at the same time an absorbing surface; and, finally, that while we chiefly contemplate the intestinal canal, as imbibing and receiving the nourishment, we must not forget that it is also a secreting surface of the first importance to the economy. But at present we have merely to understand that structure and organization, by which this canal absorbs the nutritious fluid, the chyle, from the food.

In the first place, as to the terms lacteals and lymphatics, we presume that the absorbents throughout the whole length of the canal have the same structure and use; and that the term lacteals has been suggested merely by the colour of the fluid which is absorbed from the small intestines. At one time these lacteals convey a milky fluid; at another a transparent fluid, like that which the stomach and great intestines in general absorb.

The lacteals, as it is natural to suppose, were the first discovered of any part of the system of absorbents; or, at least, they were first understood to form a part of an absorbing system. For although Eustachius, a Roman anatomist, discovered the thoracic duct in the year 1563, yet he had very imperfect notions of its importance, and the discovery was very little attended to till after the discovery of the lacteals by Asellius in 1622. This anatomist, in opening living animals, to observe the motion of the diaphragm, saw white filaments on the mesentery, which he took at first for nerves; but, on puncturing them, and observing them to discharge their

contents and to collapse, he proclaimed his discovery of a new set of vessels — a fourth kind.*

Had Asellius only chanced to observe these vessels, his merit would have been inconsiderable; but he also investigated and announced their peculiar office, viz. of absorbing the chyle from the intestinal canal, and carrying it into the blood.

For some time, however, after the discovery of the vasa lactea, the opinion of Hippocrates and Galen, that the mesenteric veins absorbed the chyle from the intestines, and conveyed it to the liver, still prevailed. Even after the discovery of the lacteals was known and received, a part of the old system was still retained, and it was supposed that those vessels carried the fluids absorbed from the intestines into the liver; and that the chyle was there converted into blood.

About twenty years after the discovery of Asellius, Rudbeck, a Swede, and Bartholin, a Danish anatomist, saw Asellius's vessels in many other parts of the body; discovered the trunk of the system, and showed that the lacteals did not pass to the liver, but that they were branches of a totally distinct system of vessels; they also demonstrated the unity of this system.

We have seen from this sketch that the ancients supposed the veins of the intestines to be absorbents; and even after the discovery of the lacteals, this idea was retained by some of the best modern anatomists, and principally by Haller and Professor Meckel of Berlin. If the veins absorb from the surface of the intestines, their doctrine would imply that they are also absorbents in general throughout the body. Although Bartholin, in his epistle to Harvey, had asserted and given sufficient proof that the mesenteric veins were not absorbents, yet the controversy was left in so undecided a state, as to give occasion to the series of experiments in the school of the Hun-

* The nerves being counted as vessels; there were arteries, veins, nerves, and lymphatics.

ters, which seems to have put the question to rest, in as far as it is connected with the lymphatic system.*

We have already mentioned that Asellius was employed in opening the belly of a living dog, when he first discovered the lacteals. He perceived upon the surface of the intestines and mesentery a great many small threads, which, at first sight, he took for nerves, but soon discovered his error; and to dissipate his doubt, opened one of the largest white cords, when no sooner had the incision been made, than he saw a fluid like milk or cream issue from the vessels. Asellius says he could not contain his joy at the sight of this phenomenon; and, turning himself to Alexander Tadinus, and the senator Septalius, who were present, he invited them to enjoy the spectacle; but his pleasure, he adds, was of short duration, for the dog died, and the vessels disappeared. The natural and simple narration of Asellius represents his astonishment, and gives an idea of the sensation, which the anatomist experiences in the instant of making an interesting discovery.

Origin of the lacteals. — When the young anatomical student ties the mesenteric vessels of an animal recently killed, he finds the lacteals gradually swell; he finds them turgid, if the animal has had a full meal, and time has been afforded for the chyle to descend into the small intestines; he finds them empty, or containing only a limpid fluid, if the animal has not had food. When he sees this, he has had sufficient proof that these are the vessels for absorbing the nutritious fluids from the intestines. Again, when coloured fluids thrown into the intestines of a living animal are absorbed, there is sufficient proof of the free communication, and that the extremities of the lacteal are absorbing mouths; but the actual demonstration of the absorbing mouths of the lacteal vessels is very difficult. The difficulty arises from

* See the Veins in this volume.

these vessels being in general empty in the dead body, from the impossibility of injecting them from trunk to branch in consequence of their valves; and, lastly, from their orifices never being patent, except in a state of excitement. The anatomist must therefore watch his opportunity when a man has been suddenly cut off in health, and after a full meal. Then the villi of the inner coat may be seen turgid with chyle, and their structure may be examined. Perhaps the first observations which were made upon this subject by Lieberkuhn, are still the best and the most satisfactory.

The villi are apparently of a cellular structure, for although they are flat or conical, or like filaments when collapsed; yet when minutely injected, and especially when they are full of chyle, they take a globular form, and are called the AMPULULÆ. Their distention, in consequence of a minute injection of the veins or arteries, is probably owing to their cellular structure and into which the injection is extravasated. This cellular structure is a provision for their distention and erection by the blood, when excited by the presence of the chyle in the intestines; this erection gives rigidity to the orifice of the lacteals; the first absorption being by capillary attraction, while the further propulsion of the fluid in the extreme absorbents is by the contraction of their coats excited by the presence of the fluid. Thus the absorption is not by an inorganized pore, but depending on excitement and action.

Lieberkuhn's observations of the villi are the most accurate and curious. He observes, that having opened and washed a portion of the small intestine, its whole surface will be found covered with little pendulous conical membranes of the fifth part of a line in size, and the basis of which almost touch each other. From the vascular membrane, to which they are attached, he observes there is given off to each villus a branch of a lacteal, an artery, a vein, and a nerve. He found it difficult by injection to show

both the vein and artery, the fluid passed so easily from the one into the other. He found that the extreme branch of the lacteal was distended into a little vessel within the villus; and surveying the apex with his microscope, he saw one, or, sometimes, several openings. He also observed, with his glasses, the arteries ramifying on the ampululæ, and again collecting into veins; and he supposed that still more minute branches plunged into the centre. But he made a still more minute observation than this. Insulating a piece of intestine betwixt two rings, only leaving a space for the entrance of the ramification of the artery which supplied it, he injected with a column of mercury, and examined its progress at the same time with his microscope. As he raised the tube, he saw the artery going in serpentine turns to the villus, and the injection returning by the veins; at last the injection passed into the ampulla lactea, distended it, and made its exit by the foramina. He prepared the villi in another way:—he inflated the ampullæ, and kept them so until they dried; then he cut them with a razor, and found them cellular. This cellular structure Cruickshanks thinks is the common cellular substance, uniting the vessels of the villus. When this gentleman examined the villi of a patient who died suddenly after a meal, he observed some of them to be turgid with chyle, so that nothing of the ramifications of the arteries or veins were to be observed; the whole appeared as one white vessel without any red lines, pores, or orifices; others of the villi contained chyle in a less proportion; and here the ramifications of the veins were numerous, and prevailed by their redness over the whiteness of the villi.

Among some hundred villi he saw a lacteal vessel forming by radiated branches, one branch from each villus.

Mr. Cruickshanks has remarked a deep and a superficial set of lacteals on the intestines; but for this

division there seems no necessity. Deep in the coats the lacteals seem to accompany the blood vessels; but when they get more superficial, they take a course longitudinally on the canal, and after running a little way, they take a sudden turn towards the mesentery.

As the greater frequency of the valvulæ conniventes in the jejunum, greatly increase the extent of the inner surface of that gut, and consequently give a greater extent of origin to the lacteals; and, as here the chyle must be in the greater quantity, so the lacteals of this portion of the gut are larger and more numerous than in any other part of the canal.

The lacteals do not attach themselves to the vessels of the mesentery, but take a more superficial course. Before they enter the mesenteric glands, they have been called lacteals of the first order; when they emerge from the first into the second glands, secondary lacteals, or glands of the second order. The manner of their entering and going out of glands is exactly the same with that of the lymphatics. The lacteals (or perhaps we should now say the absorbents merely) of the great intestines are smaller and less numerous than those of the small intestines; for although the intestines be large, still their inner surface is by no means so extensive: besides, the chyle is absorbed, and the contents of the gut altered before they have descended into the great intestines. Both Winslow and Haller, however, assert that they have seen chyle in the absorbents of the great intestines. We know that the lacteals absorb chyle when it is presented to them: while at other times they absorb other fluids. That the absorbents of the great intestines imbibe the fluid contents is evident, from the change produced on the fæces in their passage. Copious and nutritious injections have been given, which did not return in the same liquid form, and which have supported the strength for some time.

Clysters of turpentine give the urine a smell of violets; and the Peruvian bark has cured fever when given by the rectum.

The absorbents of the stomach form three divisions: one set accompanies the coronary artery and vein, and enters the glands on the lesser curvature of the stomach and the omentum minus. Those of the second set accompany the left gastro-epiploic artery, and are joined by the lymphatics of the omentum. The third pass down upon the upper part of the duodenum, following the arteria gastro-epiploica dextra: these descend to pass into the same class of glands, which receive the lymphatics of the liver. The lymphatics of the stomach are joined in their course by the lymphatics of the right side of the omentum.

The lacteals on the mesentery pass from one gland to another, till they form one or two large trunks only. These accompany the trunk of the superior mesenteric artery, and run down on the right side of the aorta, and join the thoracic duct. The absorbents, from the rectum and colon of the left side, pass into their proper glands, or sometimes into the lumbar glands, and join the thoracic duct separately; those from the right side of the colon join or mingle with the lacteals in the root of the mesentery.

## OF THE REMAINING ABSORBENTS OF THE SOLID VISCERA.

Where the lymphatics of the lower extremity descend over the brim of the pelvis, they are joined by the absorbents of the bladder, vesiculæ seminales, and other parts in the pelvis: — small glands belonging to this set are attached to the internal iliac vessels. In the female, the lower set of lymphatics, from the womb and vagina, also come by this route to join those of the lower extremity, or run mingling with them. Another set of lymphatics of the womb pass up with the spermatic vessels.

The lymphatics of the TESTICLE are very numerous. They come in distinct sets from the body of

the testicle, from the epidydimis, and from the tunica vaginalis: then reaching the cord, form six or ten trunks, and run up direct to the abdominal ring; passing the ring, they turn outward, and then pass over the psoas muscle and into the lumbar glands.

The lymphatics of the KIDNEY are in two sets, superficial and deep-seated; but the former are seldom to be observed. Sometimes disease makes them distinct. The internal lymphatics are demonstrated by blowing into the veins, or tying a ligature and kneading the substance of the kidney with the fingers; when they rise, they are seen attached to the emulgent vessels, and go to join the lumbar glands, or terminate in large lymphatics near the aorta.

It is needless to repeat that the absorbents of the spleen are deep and superficial, — for this arrangement is general in the solid viscera. Emerging from the spleen, the lymphatics pass along the splenic vessels, and enter into glands attached to the splenic artery in its whole course. In this course they receive the absorbents from the pancreas, and near the head of the pancreas they are joined with those of the liver, and with them enter into the thoracic duct.

The lymphatics of the liver are the most easily detected, and they may be injected to greater minuteness, than any other lymphatics of the body. Although they have many valves, yet they do not seem to close the vessels entirely, nor interrupt the mercury from passing from trunk to branch. The superficial lymphatics, which are so numerous that we may sometimes see the mercury in them covering completely and obscuring a considerable part of the liver, have free communication with the internal set of vessels which are also numerous and large. The principal route of the lymphatics of the upper surface of the liver is by the broad ligament: these perforating the diaphragm, join the trunk, which we have noticed under the sternum, and in the anterior mediastinum. It would appear, however, that these lymphatics of the broad or suspensory ligament, are by

no means constant and uniform in their course: for sometimes they run down towards the lateral ligament, and perforate it there; sometimes they pass down into the thoracic duct while still in the belly. While other lymphatics of great size run off from the convex surface of the liver upon the lateral ligaments, and pierce the diaphragm there. The lymphatics on the lower or concave surface of the liver are more irregular than those of the convex side. They unite with the deep lymphatics coming out of the porta along with the vena portæ, enter into the glands, which are seated on the trunk of that vessel, and join the thoracic duct near the root of the superior mesenteric artery.

The lymphatics of the LUNGS are nearly as numerous as those of the liver; but, indeed, it is more in relation to the facility of injecting and demonstrating the lymphatics, than to their comparative number, that we speak of them in this manner. For example, if the lymphatics of the other viscera could be injected to as great minuteness as those of the liver, we should cease to consider that viscus as more abundantly supplied than other parts. The superficial lymphatics of the lungs form areolæ, and cover the surface almost completely. They take a course to the root of the lungs, where they are joined by the deep-seated vessels, and together pass into the bronchial glands, and here the lymphatics of both sides freely communicate.

The glands of the lungs are constantly found both before and behind the bifurcation of the trachea; often these glands are of a very dark colour, nay, their substance is often found resolved as it were into a sac of inky-like fluid. Upon the arch of the aorta and the root of the great branches are the CARDIAC GLANDS, which receive the lymphatics from the heart. The absorbents from the heart are small but very numerous, and their larger branches attach themselves to the coronary vessels; they then pass to the cardiac glands and unite with the lymphatics which come from the lungs, and so join the thoracic duct.

# OF THE BRAIN AND NERVES.

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## OF THE NERVOUS SYSTEM.

THE nervous system embraces the brain, the nerves, and the organs of sense.

The brain is defined to be that soft mass contained within the cranium, from which the nerves are propagated. The nerves are those white cords visible every where in the parts of the body, having sensation or motion. The organs of the senses are the expanded extremities of certain nerves, within a structure capable of conveying the external impressions to them. The capacity of receiving impressions, the endowment of thought and feeling, and the power of putting the muscular machine into action, are the great attributes of the nervous system.

That sensibility is seated in the nerves, there can be no doubt. Is there any ground for supposing that a different part of the animal compound possesses the same property? It were unphilosophical to suppose so. Where similar qualities or endowments reside, we discover a resemblance in the matter of animal bodies; and it would be foreign to all analogy if two different kinds of matter possessed the same properties. For these reasons I hold, that the susceptibility of receiving impressions, which is the grand distinction of living matter, and the origin of all that is peculiar in the intestinal changes which animals undergo, results from the presence of nervous matter.

If sensibility, in its broadest meaning, results from the presence of nervous matter, then it must be, as anatomy in part proves, and many celebrated men have concluded — the matter of nerve must be ex-

tensively distributed, and extend where nervous cords cannot be traced. We have proof of sensibility, that is, of impressions received, and actions thereby excited, where no nerves are visible. And we know that animals, without possessing nervous cords, are susceptible of the impressions and of the re-actions necessary to their existence.

Matter similar to what we see accumulated in masses and in the nerves is expanded every where; and the susceptibility which distinguishes living matter is inherent in it; and through it, therefore, is the most essential endowment of animal bodies bestowed.

Every part having its proportion of nervous matter, and possessing properties through it, what uses are we to attribute to the nervous cords which we see extended through the body, and the nervous masses connected with them?

### STRUCTURE OF A NERVE.

The nerves are firm white cords, which are dispersed through the body, and extend to every part which enjoys that sensibility which gives rise to perception, and to every part having a concatenated action with another.

Nerves differ in form; but this appears to be a result arising from their place and relations, rather than connected with any peculiarity of function.

They vary in firmness and density also; but this, like their form, depends upon their places: where they lie protected from injuries, they are soft; when exposed, they are provided with a harder covering.

The matter of a nerve is all that is peculiar in it; for the manner in which that matter is bound up does not differ from the structure of a bone or a muscle. As the phosphate of lime is bound up in cellular membrane, as the muscular fibre is surrounded with cellular membrane, so is the peculiar matter of the nerves bound up and supported by the cellular textures.

Wherever we discover the matter of the nerves, it has certain qualities which distinguish it, whether in masses, as in the brain, or in the organs of the senses, or in the nerves themselves. It is a soft pulpy matter which drops from the probe, being betwixt fluid and solid. When putrid, it acquires a green colour ; when dried, it is transparent : corrosive sublimate and muriate of soda harden it ; alkalis dissolve it.

The matter of nerve in health, and in the full exercise of its influence, is of an opaque white ; by want of use, the matter is either not secreted in due proportion, or it changes its appearance, for the nerve then acquires a degree of transparency.

The coats of a nerve are forms of the cellular texture, and are three in number. They resemble the coats of the brain in structure and in use, and are, as anatomists speak, derived from them, that is to say, they are continuous.

Some have supposed it possible to inject the nerves. From the nature of the proper matter of the nerve, this is obviously a thing impossible. In these clumsy experiments they have done no more than to force the mercury into the delicate sheaths of cellular texture in which the tracts of nervous matter are contained and supported.

Inattention to the structure of nerves has led to another mistake, that they have a power of contraction. They are in truth formed with a particular guard against the injury or disturbance of the proper nervous matter by the motions of the frame. Each tube of cellular membrane, or, as it is improperly termed, each fibril of the nerve, is convoluted, running not in a straight line, but zigzag. I cannot better illustrate this than by a very humble comparison with the thread drawn from a worsted stocking, which has by its form acquired an elasticity which it would not otherwise possess ; or with a brass wire which has been wound round a rod, and thereby acquired a spring and elasticity.

I am at a loss to conceive what three celebrated men of our country * aim at, when they would persuade us that nerves are irritable and contractile. For to suppose them capable of contractions or vibrations, is to suppose them sensible to the impression which causes them to contract; and is it not the nature of this sensibility into which they are enquiring? To suppose the nerves to have the property of muscular fibres, does not, I apprehend, tend much to the progress of physiological knowledge. The mind becomes familiarized to an idea which, if it were true, would not aid us in our farther progress of understanding, and as it is incorrect, leads us astray.

There is an idea prevails that some fluid or spirit is contained in the nerves, for which purpose they are supposed to be tubes. This notion has originally been derived from contemplating the brain as a great secreting organ, and the proof of it is, that it requires five times more blood than any other part; and then they ask, why should it have so much blood if it were not a secreting organ? It is wonderful how general this desire has been of interposing some visible agent to explain effects; yet for my part I am equally at a loss to conceive, how a nervous fluid, more than the vibration of a nerve, should serve to explain the phenomena of a living body.

Fluids, spirits, æther, galvanism, have at different times been supposed to be contained in the nervous tubes, which tubes, be it remembered, were equally matter of conjecture; and many men great in their department of philosophy have been inclined to favour the idea of galvanism being the material of life, because the body of a man after execution can be made to gape and stare, by the application of this penetrating *stimulus!*

How are the oscillations, or tremors, or vibrations of a solid, or the undulations of a fluid, to explain the varieties evinced in the nervous influences? Even if

* *Darwin*, *Home*, and *Abernethy*.

it were to be concluded that galvanism was the means employed in the animal system to stimulate the muscles, it would not follow that the sensibilities of the muscles were also owing to galvanism. Other and greater difficulties would be encountered, on the supposition of galvanism being the agent, than those we have now to contend with.

Some, like Luwenhoeck, have cut the nerves across, and examining them with microscopes, have thought that they discovered minute hollow vessels; and as it were to prove that we are destined to run ever in a circle, Sir Everard Home, in our Royal Society Transactions, has employed somebody to discover globules in the nerves through the microscope.

One of the most important considerations regarding the nerves is their supply of blood-vessels: their arteries and veins are numerous, and their dependence on the supply of blood immediate. If a limb be deprived of blood, the nerves are deprived of their powers, and sensibility is lost. If a nerve be partially compressed, so as to interrupt the free entrance of blood into it, both the power over the muscles and the reception of sensation through it are interrupted; and when the blood is admitted again, painful tingling accompanies the change. A similar and universal painful tingling accompanies the returning sensibility, and the returning force of circulation after submersion.

How much vain theory has been suggested from the simple experiment of loss of power in consequence of tying a nerve; and yet it was not the compression of the tubes of the nerve, but the obstruction of blood-vessels, which produced the effect.

The brain, the nerve of the eye, the ear, the nerves of sense and of motion, are all affected by the change of circulation; and each organ, according to its natural function, is variously influenced by the same cause — the rushing of blood into it, or the privation of its proper quantity.

## SENSIBILITY OF NERVES.

It may appear strange to question the sensibility of nerves; for has not the common testimony of mankind determined that there is nothing so exquisitely sensible as an exposed nerve. But these universal principles of belief are the very circumstances which impede the progress of knowledge on very many occasions. There remains not the slightest doubt in my mind, that there are nerves as perfectly and delicately constituted as those which give sensibility to the eye or ear, which possess no sensibility whatever. That sensibility, therefore, which conveys the impression to the sensorium, and is followed by perception or by pain, is only one out of many functions performed by the nervous system; and I cannot resist stating, that, on the morning I wrote this, I have had my finger deep in the anterior lobes of the brain, when the patient, being at the time acutely sensible, and capable of expressing himself, complained only of the integument.*

When the very seat of perception is found not to be sensible, it leads us to consider on what the varieties of sensation depend. We see that sensibility is not an accidental nor a necessary consequence of the structure of a nerve, or the presence of nervous matter, nor even the communication of that nerve with the brain. It is obvious that the sensibility results from the particular part of the brain which is affected by the nerve.

If the eye-ball is pressed, the outward integuments feel pain; but the retina gives no pain, only rings of light or fire appear before the eye. In the operation of couching the cataract, the needle must pierce the retina: the effect, however, is not pain, but to produce,

* A pistol-ball had passed through the head, and, having ascertained that it had penetrated the dura mater, by forcing my finger into the wound, I trepanned on the opposite side of the head, and extracted the ball.

as it were, a spark of fire. And so an impression on the ear, the papillæ of taste, or any organ of sense, does not produce pain; nor does the sensation excited relate to the body which makes the impression, but to the nerve, or rather, as I have said, to the part of the brain to which the nerve is related at its root. Ideas of sense are excited according to the part of the brain brought into operation by the touch of the outward nerve.

But the nerve may have no relation to outward impression. It may be a nerve purely for governing the muscular frame; and if it be constituted for conveying the mandate of the will, it will not stand related to an organ of sense in the brain, and no sensibility and no pain will be produced by that nerve. It may be a nerve of exquisite feeling in one sense, that is, it may be a cord which unites two organs in intimate sympathies, so as to cause them to act in unison; and yet being bruised or injured, it will give rise to no perception of any kind, because it does not stand related to a part of the brain, whose office it is to produce either the general impression of pain, or heat, or cold, or vision, or hearing: It is not the office of that part of the brain to produce perception at all.

These are very interesting facts, and it is obvious enough, I think, that if physiologists had known or considered the various offices of the nerves, the variety of functions performed by nerves of the same structure, and the various sensibilities of the brain, an accumulated mass of the same material, they would not have thought it a satisfactory improvement to have established vibrations and vibratiuncles, nor to have considered the whole difficulty of nervous influence explained, on the idea of a galvanic fluid being contained in tubes.

### OF GANGLIONS.

The ganglions are small reddish tumours seated in the conflux of the nervous filaments. They are

laid in a regular succession in the whole length of the body, and in the vertebral animals form a regular series down each side of the spinal marrow; the nerve of communication among them is the great sympathetic nerve.

But besides the spinal ganglions, there are others seated in the head, neck, and cavities of the chest and belly, which are very irregular in their situation and form. Of the latter, the most important from situation and connection is the semilunar ganglion, which with its fellow forms the grand centre of connection to the nerves of the abdominal viscera.

All the ganglions are in the recesses of the body, and placed like parts of importance protected from injury. Around the ganglion there is a firm, minute tissue of cellular membrane; or we may describe it as a firm dense network of fibres so interwoven as to cover the proper substance of the ganglion, at the same time that it enters intimately into its composition; the ganglion has, therefore, a firmness independent of its proper matter, and indeed foreign to the general character of nervous matter. No fat is deposited in the membranes of the ganglions or of the nerves. The colour of the ganglion differs from that of the nerves; it is redder, which is owing to the greater number of blood vessels: when blanched of the blood the ganglions are greyish, and when putrid they are of the green colour of putrid brain.

I conceive that these bodies consist of the same matter with the brain, and that all the difference observable by boiling, macerating, and applying chemical agents, is merely owing to the firmer texture of the membranes which surround them, the intention of which is evidently to protect the proper matter of the ganglion.

Dr. Monro conceived that there was cineritious matter in the ganglions, and so undoubtedly there is. Scarpa thinks they do not differ from plexuses, being only very minute subdivisions of the nervous filaments.

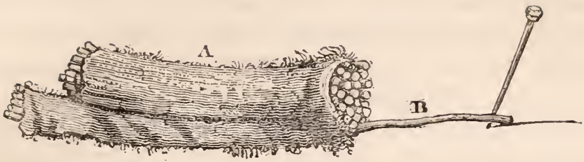
An appearance which countenances this opinion may undoubtedly be given to them by maceration and dissection; but during this process we see that a softer composition peculiar to the ganglion is washed away and lost, and Scarpa admits such a substance betwixt the filaments. Bichat errs on the other side, by affirming that there is nothing fibrous in their appearance, and that they are uniform and homogeneous.

This complicated and beautiful structure of nervous matter, protected by situation and by the support of peculiar membranous texture supplied bountifully with blood-vessels, and consisting of white and cineritious coloured nervous matter, has been supposed to be only a means of cutting off the course of sensation to the brain along those nerves which possess such knots or ganglions. But they are undoubtedly organs of importance; and how great their importance may be to the system, will be better gathered from the following comparative view of the system of the brain and nerves.

## AN EXPOSITION OF THE NATURAL SYSTEM OF THE NERVES, ACCORDING TO THE DISCOVERIES OF THE AUTHOR.

The nerves of the human body are, beside the nerves of vision, smell, and hearing, four systems combined into a whole. Nerves entirely different in function extend through the frame; those of sensation; those of voluntary motion; those of respiratory motion; and, lastly, nerves which from their being deficient in the qualities that distinguish the three others, seem to unite the body into a whole, in the performance of the functions of nutrition, growth, and decay, and whatever is directly necessary to animal existence.

These nerves are sometimes separate; sometimes bound together; but they do not, in any case, interfere with or partake of each other's influence.




The figure represents a nerve, consisting of distinct filaments. A the nerve; B one of the threads dissected out.

If we take up a nerve to examine it, we find that it consists of distinct filaments; but there is nothing in these filaments to distinguish them from each other, or to declare their offices. One filament may be for the purpose of sensation; another for muscular motion; a third for combining the muscles when in the act of respiration. But the subserviency of any of all these filaments to its proper office must be discovered by following it out, and observing its relations, and especially its origin in the brain and spinal marrow. In their substance there is nothing particular. They all seem equally to contain a soft pulpy matter enveloped in cellular membrane, and so surrounded with a tube of this membrane as to present a continuous track of pulpy nervous matter, from the nearest extremity in the brain to the extremity which ends in a muscle or in the skin.

Previous to the observations which I have made, such a nerve as I have described was supposed to have all its threads alike; they were supposed to be branches from the same root, and all capable of exciting a muscle or conveying a sensation.

The key to the system will be found in the simple proposition, that each filament or track of nervous matter has its peculiar endowment, independently of the others which are bound up along with it; and that it continues to have the same endowment throughout its whole length. If we select a filament of a nerve, (for example, one of those in the compound nerve represented above,) and if its office be to convey sensation, that power shall belong to it in all its

course wherever it can be traced: and wherever, in the whole course of that filament, whether it be in the foot, leg, thigh, spine, or brain, it may be bruised, or pricked, or injured in any way, sensation and not motion will result; and the perception arising from the impression will be referred to that part of the skin where the remote extremity of the filament is distributed.

As the matter of the nerve is every where the same, and the apparent difference is only in the manner in which the fine cellular membrane forms the envelope, (it being soft where the nerve is protected, hard and cordlike where it is exposed or subject to pressure;) I have been desirous of having some term or terms which might be applicable to the same track of matter through its different stages, whether traced in one direction or the other.

Where certain whitish streaks of nervous matter are discoverable in the substance of the brain, we may still use the term *Tractus*, as being already an anatomical term.

Where, in any part, the line of a nerve is not merely discoverable by its colour, or the direction of its texture, but when it is raised, and exhibits an external convexity in form of a cord, the term *Column* or *Rod* may be used.

Where they emerge in distinct threads, *Funiculi* has seemed to me a proper term; and where these *funiculi* are projected in combination, I use the word *Fascis*. Although we must keep the term *Nerve*, yet it is, as we may say, an abused term. Let us only distinguish betwixt a simple and a compound nerve. A simple nerve is where the threads or funiculi which form its root arise in a line or sequence from the brain or spinal marrow. A compound nerve is where the threads forming the roots arise in double rows, and each row from a different column or track of nervous matter; for example, the Ninth Nerve is simple; a Spinal Nerve is compound.

A Nerve, then, is a cord composed of nervous

matter and cellular substance; the nervous matter is in distinct funiculi, and these funiculi are bound together in their course to the point of distribution, and may possess properties quite dissimilar.

If we were successfully to trace a nervous cord, (we shall suppose from a muscle of the fore-arm,) it would be found a simple filament, thread, or funiculus. We should then trace it into a compound nerve; perhaps the ulnar nerve; which we call compound, because there are in it filaments of motion and filaments of sensation bound together. At the root of the axillary nerve we should trace it into the composition of a fascis, where it forms the anterior root of a spinal nerve. Being further traced, it would merge in the anterior column of the spinal marrow; and traced into the base of the brain, it might be followed as a *tractus*, a streak of matter distinguishable from the surrounding substance, until it was seen to disperse and lose itself in the cineritious matter of the cerebrum. In all this extent, however combined or bound up, it constitutes one organ, and ministers to one function the direction of the activity of a muscle of the hand or finger. Even in this respect is its operation perfectly simple, for while it excites the muscle to change its state, which we call its state of contraction or of relaxation, does it also convey to the sensorium a sense of the condition of that muscle?*

And so if we trace other fasciculi or, rather filaments, whether they be for the purpose of sensation or of motion, each retains its office from one extremity to the other; nor is there any communication betwixt them, or any interchange of powers, further than that a minute filament may be found combined with filaments of a different kind, affording a new property to the nerve thus constituted, that is to say, it accompanies it, and gives an additional power to the part where it is ultimately distributed.

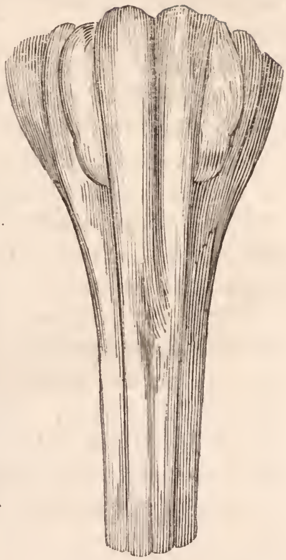
* This, it would be easy to prove, is a very important consideration in studying the organs of the senses.

## THE CAUSE OF THE COMPLEXITY OF NERVES.

It was the chief purpose of my papers in the Philosophical Transactions, to explain the cause of the seeming intricacy of the nerves of the face, neck, and thorax: but independently of the complexity arising from the causes afterwards to be explained, there are these: — It will be readily understood that some degree of irregularity in the distribution of nerves, must arise from their being compound nerves; but the principal cause is the necessity of arranging and combining a great many muscles in their different offices. Wherever we trace nerves of motion, we find, that, before entering the muscles, they interchange branches, and form an intricate mass of nerves, or what is termed a *plexus*. This plexus is intricate in proportion to the number of the muscles to be supplied, and the variety of combinations into which the muscles enter, while the filaments of nerves which go to the skin regularly diverge to their destination. The nerves on the face, and those on the side of the neck, form plexus; but the grand plexus are near the origins of the nerves of the upper and lower extremity. And from the fin of a fish to the arm of a man the plexus increases in complexity in proportion to the variety or extent of motions to be performed in the extremity.

The explanation of a plexus which I have offered, is founded on these facts; viz. that by the interchange of filaments, the combination among the muscles is formed: not only are the classes of extensors and flexors constituted in the plexus, but all the varieties of combinations are there formed, and the curious relations established which exist between opposing muscles, or rather between the contraction of one class and the relaxation of the other.

## THE SPINAL MARROW.*



In this view of the nerves the internal and radical distinctions are more insisted upon, than that enumeration of their origin and description of their devious course through the body which have hitherto served only to confound the enquirer. We must, therefore, begin the description of the system with that of the spinal marrow. It is by a right arrangement of matters which are familiar, and by attention to a few remarkable and prominent facts, that the ground-work of this system will be best understood.

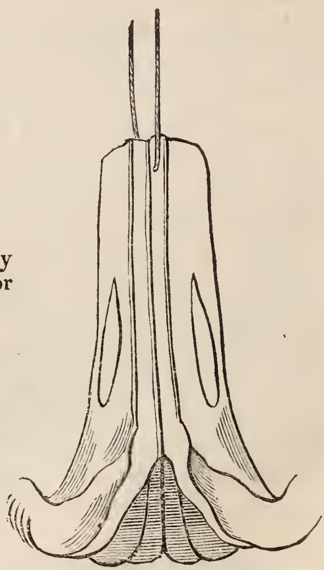
The spinal marrow is peculiar to the vertebral animals. It will suffice for superficial observers to say, that it must be so, because the spine is necessary to conceal and protect the marrow: but there is much more than this in the established relationship; the spine formed by vertebræ is necessary to such a constitution of the thorax as shall be capable of the motion of respiration; and the spinal marrow is equally necessary to that form and distribution of the nervous system which is required for associating and combining the muscles of respiration. Without the machinery of the spine and ribs, the thorax and abdomen could not rise and fall in respiration; and without the spinal marrow that arrangement of nerves would be wanting, which is necessary to regulate the motions of the trunk in respiration. Thus the spinal

* I have represented above, in a general way, the columnar appearance of the spinal marrow at its upper part; that superior extremity, which, being traced out of the base of the brain, is called *medulla oblongata.*

marrow, the spine and ribs, and the muscles of respiration, are essential to each other; as constituting the several parts of a grand design subservient to respiration.

Different columns of nervous matter combine to form the spinal marrow. Each lateral portion of the spinal marrow consists of three tracks or columns; one for voluntary motion, one for sensation, and one for the act of respiration. So that the spinal marrow comprehends in all six rods, intimately bound together, but distinct in office; and the capital of this compound column is the *medulla oblongata*.

These six columns of the spinal marrow are discoverable on looking to the fore part of that body; but no doubt these grander columns contain within them subdivisions. Thus, if we lift up the medulla spinalis from the cerebellum, and look to it on the back part, we shall see more numerous cords, the offices of which will one day be discovered.



The medulla oblongata, raised by a thread, so as to expose the posterior surface.

This view of the constitution of the spinal marrow led me to institute experiments, which were followed

by the discovery of the distinct functions performed by the several roots of the spinal nerves; but without stating these experiments or their results, we shall proceed with the general view.

The anterior column of each lateral division of the spinal marrow is for motion; the posterior column is for sensation; and the middle one is for respiration. The two former extend up into the brain, and are dispersed or lost in it; for their functions stand related to the sensorium: but the latter stops short in the medulla oblongata, being in function independent of reason, and capable of its office independent of the brain, or when separated from it.

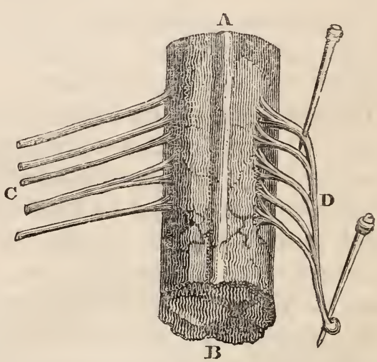
It is the introduction of the middle column of the three, viz. that for respiration, which constitutes the spinal marrow, as distinct from the long central nerve of the animals without vertebræ, and which is attended with the necessity for that form of the trunk which admits of the respiratory motions.

In animals which do not breathe by a uniform and general motion of their bodies, there is no spinal marrow, but only a long compound and ganglionic nerve, extending through the body for the purpose of sensation and motion. This cord in those creatures does not actuate the animal machine with alternate dilatation and contraction. There may be a motion of some part which admits and expels air from a cavity, or agitates the water, and which motion is subservient to oxygenation of the blood; and there may be a nerve supplied to that apparatus with sensibility and power suited to the function thus to be performed, and resembling our par vagum in office; but there is no regular and corresponding distribution of a respiratory system of nerves to both sides of the body, and no arrangement of bones and muscles, for a general and regular motion of the frame like that which takes place in vertebral animals, and which is necessary to their mode of existence.

## OF THE NERVES WHICH ARISE FROM THE SPINAL MARROW.—COMPARISON WITH THE NERVES OF THE ENCEPHALON.

The first conception which I entertained of the true arrangement of the nerves, arose from a comparison of the nerves which take their origin from the brain, with those which arise from the spinal marrow. The perfect regularity of the latter, contrasted with the very great irregularity of the former, naturally led to an inquiry into the cause of this difference. I said, if the endowment of a nerve depend on the relation of its roots to the columns of the spinal marrow and base of the brain, then must the observation of their roots indicate to us their true distinctions and their different uses.

The spinal nerves are perfectly regular in origin and distribution, and are thirty on each side.* Each nerve has two distinct series of roots coming out in packets or fasces, one from the posterior column, and one from the anterior column, of the spinal marrow.

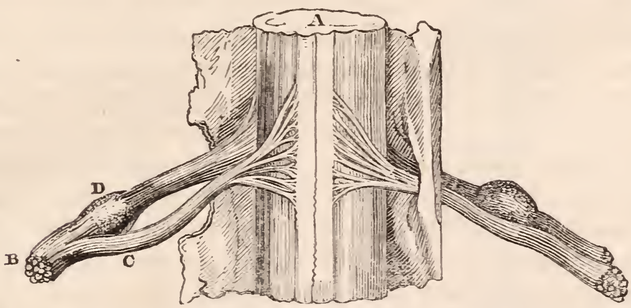



A B the spinal marrow seen laterally; C the posterior roots of a spinal nerve; D the anterior roots of the same nerve pinned out.

The posterior fascis is formed of funiculi, which

* The tenth nerve of the head, as enumerated by Willis, and called suboccipital from its situation, is in constitution a spinal nerve, *i.e.* it has a double root, a ganglion on its posterior root, and its distribution is similar to the spinal nerves, quite unlike those of the encephalon.

come out with remarkable abruptness from the column; and their roots form a very regular row or series along the sides of the spinal marrow. They seem at once to burst out from the confinement of the arachnoid coat. These funiculi, converging towards the foramen of the sheath of the spinal marrow, and being collected together, form a ganglion. This ganglion is not seen within the sheath of the spinal marrow; its seat is in the part where the fascis is surrounded and united to the sheath, and just before this root of the nerve joins the anterior one to constitute a spinal nerve.



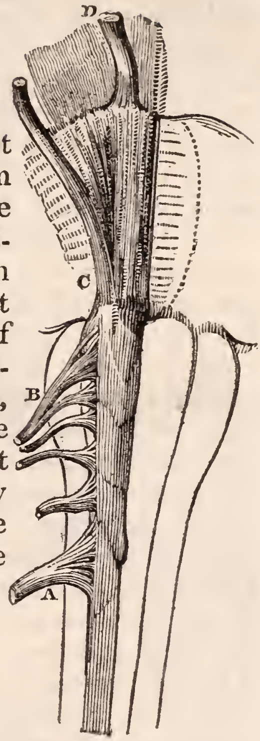

A the spinal marrow seen in front; B a spinal nerve; C the anterior root of the spinal nerve; D the ganglion on the posterior root.

The funiculi of the anterior roots of these nerves gather their minute origins with more irregularity than the posterior; and from a wider surface.

The thirty nerves thus formed of two distinct fasciculi, are suited to perform all the offices of the trunk and limbs. Is it, then, by that combination of properties which they acquire through their double roots, that they are capable of performing their offices? And is this the cause of their simplicity of arrangement in their course through the body, as contrasted with the nerves of the head? Again, what cerebral nerves, in their distribution to the head and face, correspond in office with the spinal nerves? On the solution of these questions will depend our knowledge of the whole nervous system.

It was necessary to know, in the first place, whether the phenomena exhibited on injuring the separate roots of the spinal nerves corresponded with what was suggested by their anatomy. After delaying long on account of the unpleasant nature of the operation, I opened the spinal canal of a rabbit, and cut the posterior roots of the nerves of the lower extremity; the creature crawled, but I was deterred from repeating the experiment by the protracted cruelty of the dissection. I reflected, that an experiment would be satisfactory, if done on an animal recently knocked down and insensible; that whilst I experimented on a living animal, there might be a trembling or action exerted in the muscles by touching a sensitive nerve, which motion it would be difficult to distinguish from that produced more immediately through the influence of the motor nerves. I therefore struck a rabbit behind the ear, so as to deprive it of sensibility by the concussion, and then exposed the spinal marrow. On irritating the posterior roots of the nerve, I could perceive no motion consequent, on any part of the muscular frame; but on irritating the anterior roots of the nerve, at each touch of the forceps there was a corresponding motion of the muscles to which the nerve was distributed. These experiments satisfied me that the different roots and different columns from whence those roots arose, were devoted to distinct offices, and that the notions drawn from the anatomy were correct.

The anterior roots of the spinal nerves, and the anterior column of the spinal marrow, being thus shown to have a power over the muscular system, the next step of the enquiry was distinctly indicated. If I pursue the track of the anterior column of the spinal marrow up into the brain, shall I find the nerves which arise from it to be muscular nerves? An anatomist will at once answer, that only muscular nerves arise in this line.




We see here the anterior root of the spinal nerve, arising from the column at A. We trace the column up into the corpus pyramidale, and find there the origin the ninth nerve B. We see that this nerve has only one series of roots, corresponding with the anterior roots of the spinal nerves, and that these roots come from the *tractus motorius*, and we cannot forget that this nerve is entirely devoted to the muscles of the tongue; that it is the motor of the tongue.

Following up the corpus pyramidale, we find issuing from it the sixth nerve, a muscular nerve of the eye. Still following up the *tractus motorius* through the *pons varolii*, we come to the roots of the third nerve, the motor nerve of the eye. Thus all the nerves arising in one line from the crus cerebri to the cauda equina are muscular nerves; and no nerves of a different kind arise in all this line.

On finding this confirmation of the opinion, that the anterior column of the spinal marrow, and the anterior roots of the spinal nerves were for motion, the conclusion presented itself that the posterior column and posterior roots were for sensibility. But here a difficulty arose. An opinion has prevailed that ganglia were intended to cut off sensation; while

every one of the nerves, which I supposed were the instruments of sensation, had ganglia on their roots.

Some very decided experiment was necessary to overturn this dogma. I selected two nerves of the encephalon; the fifth, which had a ganglion, and the seventh, which had no ganglion. On cutting across the nerve of the fifth pair on the face of an ass, it was found that the sensibility of the parts to which it was distributed was entirely destroyed. On cutting across the nerve of the seventh pair on the side of the face of an ass, the sensibility was not in the slightest degree diminished.

By pursuing the enquiry, it was found that a ganglionic nerve is the sole organ of sensation in the head and face: and thus my opinion was confirmed, that the ganglionic roots of the spinal nerves, were the fasces or uniculi for sensation.

It now became obvious why the third, sixth, and ninth nerves of the encephalon were single nerves in their roots, as contrasted with the spinal nerves: for if the fifth nerve bestowed sensibility universally on the head and face and all the parts contained, there was no necessity, so to speak, for the third, sixth, and ninth, having the posterior or ganglionic root.

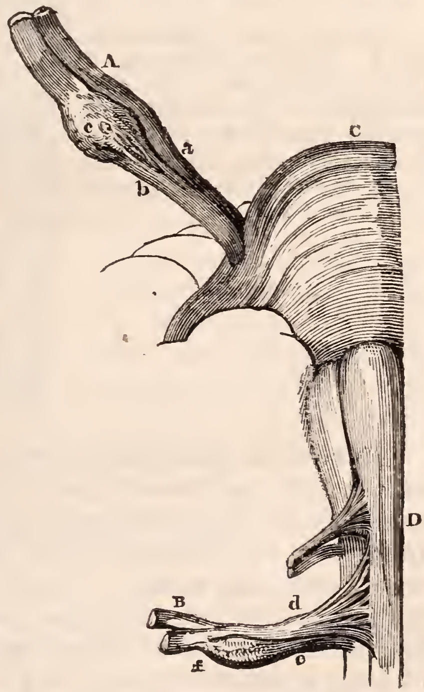
Pursuing the subject and still directed by the anatomy, the next matter of enquiry was to ascertain how far the fifth nerve of the encephalon corresponded with the spinal nerves. It was discovered that the fifth nerve bestowed sensibility on all the cavities and surfaces of the head and face. It was also observed, that where the sensibility of the integuments remained after the division of the fifth nerve, it was only to the extent of surface supplied by the nerves of the spine. Where certain fibrils of the spinal nerve extend upon the integuments of the side of the jaw, these are equivalent in office to those of the fifth nerve. In short, in regard to their property of bestowing sensibility, the fifth and the spinal nerves were identified.

But was the fifth nerve in other essential circum-

stances similar to the spinal nerves? On recurring to the anatomy, and comparing the fifth nerve of the encephalon with a spinal nerve, the resemblance, both in man and brutes, was very remarkable. In this sketch we recognize corresponding parts. In both nerves we see the double roots; the anterior root passing the ganglion, and the posterior root falling into it or forming it. On following back the

We have an exact drawing of the 5th nerve, and one of the spinal nerves.

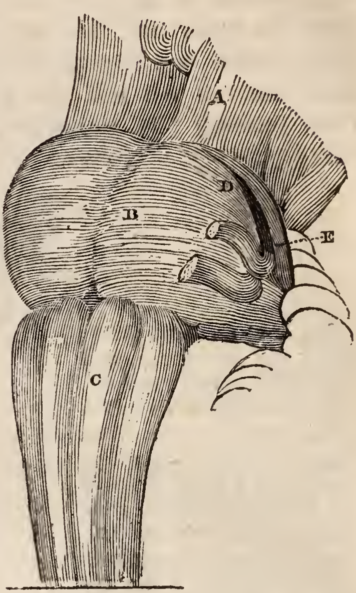
A the 5th nerve; B a spinal nerve; C the Pons Varolii; D the Corpus Pyramidale; a that origin of the 5th which has no ganglion; b the root of the 5th which has a ganglion; c the ganglion; d the anterior origin of the spinal nerve having no ganglion; e the posterior ganglionic root of the same nerve; f the ganglion.




anterior root, we may perceive that it comes out betwixt the *funes* of the Pons Varolii, and, in fact, from the crus of the cerebrum.

Observing that there was a portion of the fifth nerve, which did not enter the ganglion of that nerve, and being assured of this fact by the concurring testimony of anatomists, I conceived that the fifth nerve was in fact the uppermost nerve of the spine; that is to say, the uppermost or most anterior of those nerves which order the motion, and bestow

sensibility, in its extended sense, on the frame of the body.




A Crus Cerebri; B Pons Varolii; C Medalla Oblongata; D two ropes or funes of the pons, which part to give origin to the anterior root of the 5th nerve; E a fasciculus from the Crus Cebri, giving origin to the anterior root of the 5th nerve.

To confirm this opinion by experiment, the nerve of the fifth pair was exposed at its root, in an ass, the moment the animal was killed; and on irritating the nerve, the muscles of the jaw acted, and the jaw was closed with a snap. On dividing the root of the nerve in a living animal, the jaw fell relaxed. Thus its functions were no longer matter of doubt: it was at once a muscular nerve and a nerve of sensibility. And thus the opinion was confirmed, that the fifth nerve was to the head, what the spinal nerves were to the other parts of the body.

One circumstance I may notice in passing; the origin of the fifth nerve being above or anterior to the termination of the column of the spinal marrow for respiration, it can receive no roots from it. How then are the features to be moved in sympathy with the lungs, and with the respiratory actions of the breast, neck, and throat? We shall find presently

that this is effected through the portio dura of the seventh.

I have now only to add, that these opinions and experiments have been followed up to the satisfaction of all Europe. It has been acknowledged that the anterior roots of the spinal nerves bestow the power of muscular motion; and the posterior roots sensibility. When the anterior roots of the nerves of the leg are cut in experiment, the animal loses all power over the leg, although the limb still continues sensible. But if, on the other hand, the posterior roots are cut, the power of motion continues, although the sensibility is destroyed. When the posterior column of the spinal marrow is irritated, the animal evinces sensibility to pain; but no apparent effect is produced when the anterior column is touched.

I shall now proceed, by reference to the plate, to explain the SYMMETRICAL SYSTEM OF NERVES. We see thirty-one nerves similar in origin and constitution, ranging with perfect order, and going forth to the head, body, and limbs in regular succession; and in their essential attributes, common to every class of animals, from the creeping thing up to man.*

## EXPLANATION OF PLANS.

WHEN we contemplate the dissection which we have made of the nerves of the face, neck, and chest, and are lost in the confusion of the VIIth, VIIIth,

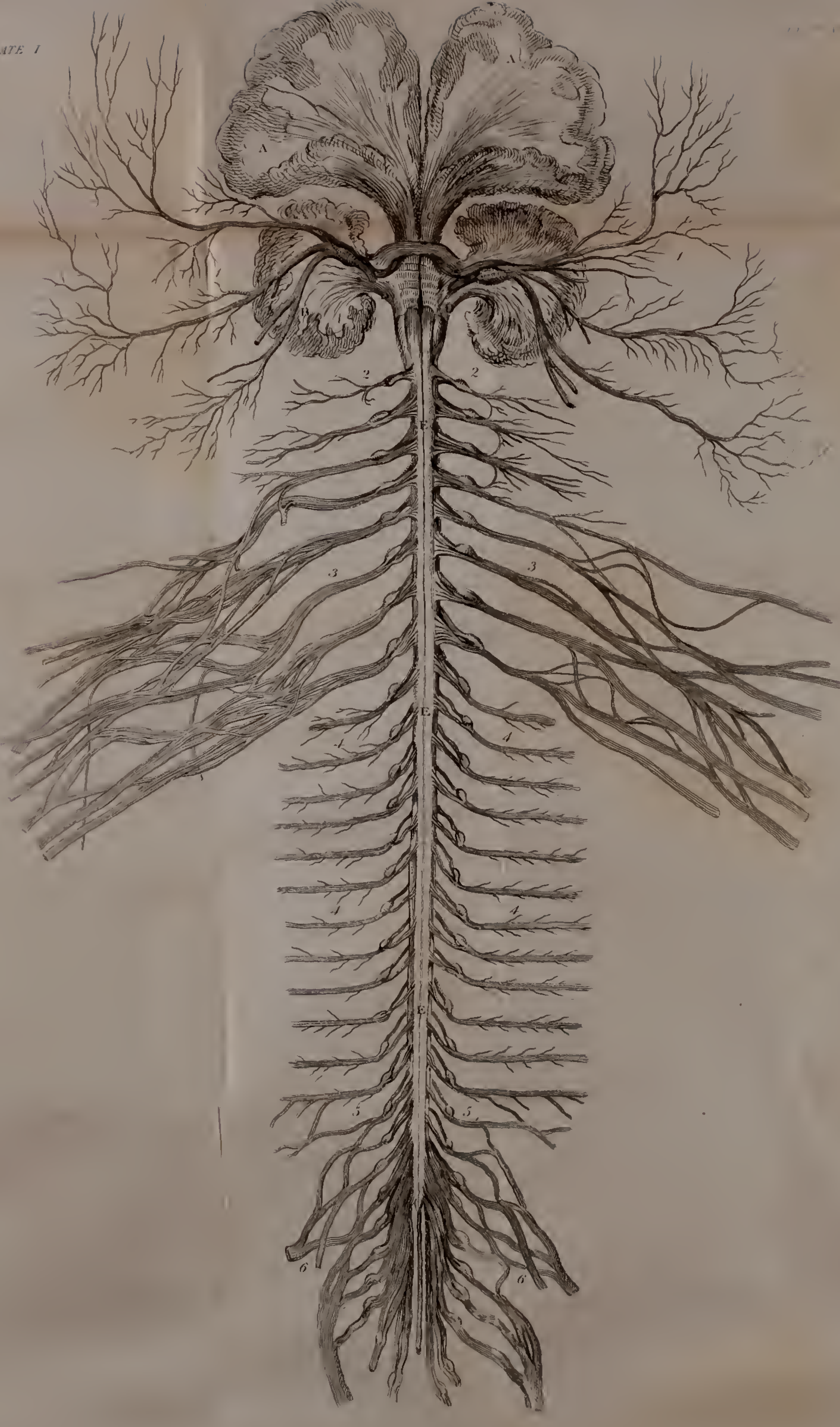
* This will be condemned as a term not systematic, but it is strictly correct. It is the necessity of a correspondence in the motions of the body and feet which, if we may so express it, calls for symmetry in the distribution of the nervous system. When a creature has no feet, or substitute for them, there is no symmetrical system of nerves. If we were to consider the necessity of correspondence in the motions of the hands and feet, as well as in the four quarters of brutes, that each foot does not move by itself, but on the contrary, that there is a combination of motion betwixt the limbs in walking, ambling, trotting, galloping, &c., we should see that the muscular system must be united by a longitudinal cord, and uniformity of branches going out laterally.

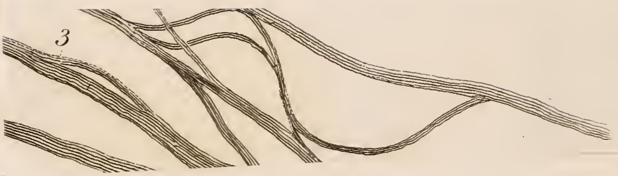
and IXth, of the branches of the Cervical Nerves, and of the Sympathetic — of the Diaphragmatic, Spinal Accessory, and Inferior External Respiratory Nerves — we shall be prepared to see the advantages of the plans which are annexed. The reader will soon discover that the system, of which the plans may give him some idea, is not only a remarkable improvement in the knowledge of the structure and functions of animal bodies, but is of the greatest use in practical anatomy in facilitating the comprehension of the nerves.

The arrangement is this: — There is an obvious division of the medulla spinalis corresponding to the cerebrum and cerebellum: every regular nerve has two roots, one from the anterior of these columns, the other from the posterior: such are the Vth pair; the Suboccipital; the seven Cervical; the twelve Dorsal; the five Lumbar; and the five or six Sacral; viz., thirty-one pairs of perfect, regular, or double nerves in the human body. These are laid down in the first plan. They are common to all animals, from the worm up to the man; and are for the purposes of common sensation and motion, or acts of volition; they run out laterally to the regular divisions of the body, and never take a course longitudinal to the body.

For the sake of arrangement, the remaining nerves are called IRREGULAR NERVES. These are distinguished by a single fasciculus, or single root; that is, a root from one column. These are *simple* in their origin; *irregular* in their distribution; and deficient in that symmetry which characterizes the first class. They are superadded to the original class, and correspond to the number and complication of the superadded organs. Of these there are — the IIId, IVth, and VIth to the eye; the VIIth to the face; the IXth to the tongue; the *Glosso Pharyngeal* to the pharynx; the *Nervus Vagus* to the larynx, heart, lungs, and stomach; the *Phrenic* to the diaphragm; the *Spinal Accessory* to the muscles of the shoulder;

PLATE I




3

the *External Respiratory* to the outside of the chest.

If we enquire into the seeming confusion in the second class, or *irregular nerves,* we shall perceive that it is owing to the complication of the superadded apparatus of respiration, and the variety of offices which this apparatus has to perform in the higher animals. To explain this the second plan is given. It presents in one view the nerves destined to move the muscles in all the varieties of respiration, speech, and expression.

We may now see how confounding is the numbering of the nerves, according to the system of Willis; and how impossible it is to make a natural arrangement while the nerves are so numbered.

## EXPLANATION OF PLATE I.

A A Cerebrum.—B B Cerebellum.—C C Crura Cerebri.—D D Crura Cerebelli.—E E E Spinal marrow.

1 1 Branches of the Vth pair, or Trigeminus, which are seen to arise from the union of the Crura Cerebri and crura cerebelli: one root coming from the crus cerebri, and another from the crus cerebelli; and on the last a ganglion is seen, like the ganglion of the spinal nerves. The branches of the Vth nerve are universally distributed to the head and face.

2 2 Branches of the *Suboccipital* Nerves, which have double origins and ganglions.

3 3 The branches of the four inferior Cervical Nerves and of the first Dorsal, forming the Axillary Plexus: the origins of these nerves are similar to those of the Vth and the Suboccipital.

4 4 4 4 Branches of the Dorsal Nerves, which also arise in the same manner.

5 5 The Lumbar Nerves.

6 6 The Sacral Nerves.

## OF THE NERVOUS CIRCLE WHICH CONNECTS THE VOLUNTARY MUSCLES WITH THE BRAIN.

I have been slow to make my particular opinions part of this general system, and I have not included my papers in these volumes, until the conclusions in them have received something like a general approbation. I shall, however, shortly notice the subject

of a paper which I gave in lately to the Royal Society.

The muscles have two nerves, which fact has not hitherto been noticed, because they are commonly bound up together. But whenever the nerves, as about the head, go in a separate course, we find that there is a sensitive nerve and a motor nerve distributed to the muscular fibre, and we have reason to conclude that those branches of the spinal nerves which go to the muscles, consist of a motor and a sensitive filament.

It has been supposed hitherto, that the office of a muscular nerve is only to carry out the mandate of the will, and to excite the muscle to action; but this betrays a very inaccurate knowledge of the action of the muscular system; for before the muscular system can be controlled under the influence of the will, there must be a consciousness or knowledge of the condition of the muscle.

When we admit that the various conditions of the muscle must be estimated or perceived in order to be under the due control of the will, the natural question arises, is that nerve which carries out the mandate of the will capable of conveying, at the same moment, an impression retrograde to the course of that influence which is going from the brain towards the muscle? If we had no facts of anatomy to proceed upon, still reason would declare to us that the same filament of a nerve could not convey a motion, of whatever nature that motion may be, whether vibration, or motion of spirits in opposite directions, at the same moment of time.

I find that to the full operation of the muscular power, two distinct filaments of nerves are necessary, and that a circle is established between the sensorium and the muscle: that one filament or simple nerve carries the influence of the will towards the muscle, which nerve has no power to convey an impression backwards to the brain, and that another nerve connects the muscle with the brain, and acting as a sen-

tient nerve conveys the impression of the condition of the muscle to the mind, but has no operation in a direction outward from the brain towards the muscle, and does not, therefore, excite the muscle, however irritated.

### OF THE SYSTEM OF NERVES CALLED RESPIRATORY.

THE observation of the frame of man or of brute, and especially the review of it in a state of high activity, or under the influence of passion, will convince us that the motions dependent on respiration extend almost over the whole body, while they more directly affect the trunk, neck, and face. We may perceive, also, that during the involuntary action of respiration the same muscles are in operation as in the voluntary actions. This is evident not only in breathing, but also in coughing, sneezing, crying, laughing, speaking, swallowing, and vomiting; for all these are states or conditions of the respiratory nerves and muscles. In every effort but that of simple voluntary motion, the respiratory organs become the agents; and even in violent voluntary efforts, or the long continuance of exercise, the instinctive motions chime in with the voluntary motions, and the activity of the frame becomes general.

Under the class of respiratory motions we have to distinguish two kinds: first, the involuntary, or instinctive; secondly, those which accompany an act of volition. We are unconscious of that state of alternation of activity and rest which characterises the instinctive act of breathing in sleep; and this condition of activity of the respiratory organs we know, by experiment, is independent of the brain. But, on the other hand, we see that the act of respiration is sometimes an act of volition, intended to accomplish some other operation, as that of smelling or speaking. I apprehend that it is this compound operation of the organs of breathing which introduces a certain degree of complexity into the system of respiratory nerves. A concurrence of the nerves of distinct systems will

be found necessary to actions which at first sight appear to be very simple.

To make this evident, before proceeding further, I shall give an example of the necessity of this combination of different powers. Let us observe, in the act of eating and swallowing, the necessary combination of the three powers of sensation, voluntary muscular activity, and the act of the respiratory muscles.

If we cut the division of the fifth nerve which goes to the lips of an ass, we deprive the lips of sensibility: so when the animal presses the lips to the ground, and against the oats lying there, it does not feel them; and consequently there is no effort made to gather them. If, on the other hand, we cut the seventh nerve where it goes to the lips, the animal feels the oats, but it can make no effort to gather them, the power of muscular motion being cut off by the division of the nerve. Thus we perceive that in feeding, just as in gathering any thing with the hand, the feeling directs the effort; and two properties of the nervous system are necessary to a very simple action.

In drinking, the fluid is sucked in by the breath, and when the mouth is full we swallow. The water is felt; the lips are moulded into the right form by volition, and the muscles of inspiration combine to draw in the fluid. In the act of swallowing, the liquid would descend into the windpipe were there not a combination of the muscles of respiration with the apparatus of diglutition to prevent it; nor could the fluid or the solid morsel pass the diaphragm without a similar coincidence of activity and relaxation betwixt parts animated by different system of nerves.

In speaking, it is still more obvious that the act of respiration must become voluntary, in order to push out the breath, in combination with the contractions of the larynx, and tongue and lips, for producing sound, and more especially articulate language.

The respiratory system must be exercised under an instinctive and involuntary impulse, as in breathing during sleep, and insensibility. But it must, at certain

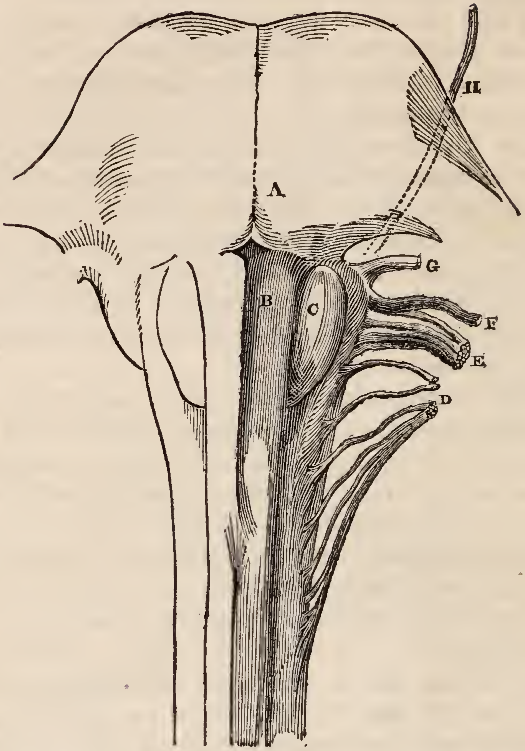
times, be associated into voluntary actions. By foreseeing this difficulty we shall avoid the danger of pushing the investigation of the anatomy too far; or of throwing a doubt over important discoveries by attempting too much.

After the investigation of the regular system of nerves of sensation and voluntary motion, the question that had so long occupied me, viz. — what is the explanation of the excessive intricacy of the nerves of the face, jaws, throat, and breast? became of easy solution. These nerves are agents of distinct powers; and they combine the muscles in subserviency to different functions.

As far as regards motion and sensation, the original and symmetrical nerves appeared sufficient to the concatenation of the muscles. By them creatures feel pain, and move and withdraw themselves from injury. But these nerves are not capable of (that is to say, were not designed for) the vital act of respiration, far less from smelling, speaking, singing, laughing, in which several acts the respiratory system is brought into activity.

As animals rise in the scale of beings, new organs are bestowed upon them. And as new organs and new functions are super-added to the original constitution of the frame, new nerves are given also, and new sensibilities, and new powers of activity.

In the act of respiration we see a succession of regular motions extending to a great part of the animal machinery; we perceive, at one glance, that this is a new species of activity, and that this new energy must be derived from a source different from locomotive powers. Looking to the simultaneous motions of the abdomen, thorax, neck, throat, lips, and nostrils, in breathing, it is obvious, in the first place, that they must be animated by nerves partaking of similar powers; and that these nerves must have a centre somewhere, so that they may be simultaneously and equally excited, and give a uniform impulse to the muscles of respiration.




A the Pons Varolii; B Corpus Pyramidale; C Corpus Olivare; D the Spinal Accessory nerve; E Par Vagum; F Glosso-Pharyngeal nerve; G Portio Dura of the seventh; H Fourth Nerve.

All these are respiratory nerves, arising in a line from the same column.

The reader will now understand the course of my reflections, when I observed that there were certain nerves arising from a distinct column of the spinal marrow, not only different from the spinal nerves, but unlike either of the roots of the spinal nerves; and that they had their roots in a row or regular series. After the course of the enquiry which I have described, it was natural to suppose that these nerves must have a distinct function, and what so probable as that pointed out by their course and distribution? viz. —

that they were connected with the offices of respiration. Observing that the Spinal Accessory nerve, the Par Vagum, the Glosso-Pharyngeal nerve, the Portio Dura of the seventh or respiratory nerve of the face, and the Fourth Nerve, arose in a distinct tract and in sequences, I conceived that they offered themselves as fair subjects of experiment; and that by an experiment the question would be determined, viz. — whether or not these five nerves connected the remote parts to which they were distributed in the act of respiration.

The consideration of the course of the Par Vagum (E) gave countenance to this idea, and the comparative anatomy of the nerve confirmed it. On comparing the experiments that had been made from time to time on this nerve, all conspired to show that its use was to combine the proper organs of respiration; while the other nerves (as D F G H) were intended to draw the exterior apparatus of muscles into sympathy with the heart and lungs. Experiments fully confirmed these opinions.

In this course of enquiry it was natural to ask why the Spinal Accessory of authors (D) arose from the spinal marrow in the neck? why it ascended into the head, to join itself with the Par Vagum, instead of following the direct and short route to its destination on the muscles of the neck and shoulder, like the spinal nerves? I divided its branches in the living animal, and by that means cut off certain muscles from partaking in the act of breathing, while they retained their office under the other nerves; that is, they remained under the direction of the will when they had ceased to be influenced by the lungs.

Directed in the next place to the Portio Dura (G), I wished to answer the question, Why does the nerve which supplies the muscles of the face take an origin and a course different from the Fifth Nerve destined to the same parts? By experiment I proved that this was the respiratory nerve of the face: and by inference I concluded, that it had the origin we see,

and took its course with the respiratory nerves; because it was necessary to the association of the muscles of the nostrils, cheek, and lips, with the other muscles used in breathing, speaking, &c. For this reason it was associated with the root of the Eighth Pair instead of the Fifth.

The course of enquiry into the functions of the branches of the Portio Dura which go to the eyelids, led me to make observations on the motions of the eyeball; and finally directed me to the Fourth Nerve (H) to account for the symphathetic motions of the eyeball in combination with the other parts moved in the excited state of respiration.

I may here observe, that on thrusting a pin or the probe into the substance of the medulla oblongata near the root of the Portio Dura (G), and then turning to the other side, we shall find that we have thrust betwixt the roots of the Fourth Nerve. *

This intricate subject is discussed in the last of the series of papers given to the Royal Society, and republished in this volume.

Nothing can better prove the importance of the principles laid down in the beginning of this exposition than the explanation which it offers of the seeming intricacy of the nerves of the orbit and of the whole head and face; and the variety of curious facts which it brings to light. These, as I have said, are detailed in the last of these papers.

It appears, then, that there are four nerves coming out of a track or column of the spinal marrow, from which neither the nerves of sensation, nor of common voluntary motion, take their departure. Experiment further proves, that these nerves excite motions dependent on the act of respiration.

There can be no hesitation or doubt that as far as the neck, throat, face, and eyes depend on, or are related to the actions of respiration, it is through these nerves that they are so associated.

* I have indicated the course of the Fourth Nerve by a dotted line.

Plan of the Nerves of Respiration

I have been always desirous of stating, that the absolute proofs stop here, and that the rest is hypothesis. I imagine that the same column or track which gives origin to the fourth, seventh, glosso-pharyngeal, par vagum, and spinal accessory nerves, is continned downward along the lateral part of the spinal marrow, and that it affords roots to the spinal nerves, constituting them respiratory nerves, as well as nerves of motion and sensation; and that it especially supplies the roots of the diaphragmatic nerve, and the external respiratory nerve.

The spinal nerves are adequate to the gentle and uniform motions of respiration, but not to the associated actions of respiration. Thus, when a creature cries, or a man speaks or sings, the muscular effort is not in the muscles of the thorax only, and directed by the intercostal nerves; but the shoulders are raised and the thorax expanded by the influence of the spinal accessory nerve, and the external respiratory nerves. The larynx is excited by the branches of the par vagum called laryngeal. The cheeks, lips, and nostrils, are directed by the Portio Dura and the Fourth Nerves.

It is remarkable that in the investigation of this subject every nerve and twig of nerve is accounted for, and its office explained, with the exception of certain divisions of the sixth nerve of the brain.

## EXPLANATION OF PLATE II.

A Cerebrum.—B Cerebellum.—CC Spinal Marrow.—D Tongue.—E Larynx.—F Bronchia.—G Heart.—H Stomach. — I Diaphragm.

1 1 1 Par Vagum, arising by a single set of roots and passing to the larynx, the lungs, heart, and stomach.

2 2 Superior laryngeal branches of the par vagum.

3 Recurrent or inferior laryngeal of the par vagum.

4 Pulmonic plexus of the par vagum.

5 Cardaic plexus of the par vagum.

6 Gastric plexus or corda ventriculi of the par vagum.

7 Fourth nerve a branch of this system to the trochlearis muscle.

8 Respiratory nerve or portio dura to the muscles of the face, arising by a series of single roots.

9 Branches of the glosso-pharyngeal.

10 Origins of the superior external respiratory or spinal accessory nerve.

11 Branches of the last nerve to the muscles of the shoulder.

12 12 12 Internal respiratory, or the phrenic to the diaphragm. The origins of this nerve may be seen to pass much higher up than they are generally described.

13 Inferior external respiratory to the serratus magnus.

It was said that we understand the use of all the intricate nerves of the body, with the exception of the sixth. The sixth nerve stands connected with another system of nerves altogether; I mean the system hitherto called the sympathetic, or sometimes the ganglionic system of nerves; and of this system we know so little, that it cannot be matter of surprise if we reason ignorantly of the connection of the sixth with it.

On reviewing the whole nerves of the human body, the sensitive, motor, and respiratory systems combined, surely these views come strongly recommended. They present a series of facts unexampled for their number and importance. Such, for instance, as the distinct functions of the nerves of the face; the fact that all sensibility in the head and face depends solely on the fifth nerve; the singular circumstance, that the common sensibility of the whole frame results from a series of ganglionic nerves extending from the head to the sole of the foot; that the act of respiration in the face, nostrils, throat, &c. results from a series of nerves differing from the common nerves: and last of all, it will not be said that I have left the question unresolved with which I set out, viz., the cause of the intricacy of the nerves of the face, neck, and chest. I have shown that the same part, as for example the tongue, has different nerves suited to its different functions; and that the intricacy arises from the interweaving of the branches of different systems. But all this has an easy explanation when we know the properties of the columns from which they proceed.

If there were no facts to give proof of the truth

of the view which I have presented, it would surely be enough to recommend it, that a subject which has been hitherto difficult, and intricate, and forbidding, has, by means of it, become interesting, simple, and satisfactory.

## INTRODUCTORY VIEW OF THE ANATOMY OF THE BRAIN.

The brain is a mass of soft matter, in part of a white colour, and generally striated; in part of a grey or cineritious colour, which has no fibrous appearance. It has grand divisions and subdivisions: and as the forms exist before the solid bone incloses the brain; and as the distinctions of parts are equally observable in animals whose brain is surrounded with fluid, they evidently are not accidental, but are a consequence of internal structure.

On examining the grand divisions of the brain we are forced to admit that there are four brains. For the brain is divided longitudinally by a deep fissure; and the line of distinction can even be traced where the sides are united in substance. Whatever we observe on one side has a corresponding part on the other; and an exact resemblance and symmetry is preserved in all the lateral divisions of the brain. And so, if we take the proof of anatomy, we must admit that as the nerves are double, and the organs of sense double, so is the brain double; and every sensation conveyed to the brain is conveyed to the two lateral parts, and the operations performed must be done in both lateral portions at the same moment.

I speak of the lateral divisions of the brain being distinct brains combined in function, in order the more strongly to mark the distinction betwixt the anterior and posterior grand divisions. Betwixt the lateral parts there is a strict resemblance in form and substance: each principal part is united by transverse

tracts of medullary matter; and there is every provision for their acting with perfect sympathy. On the contrary, the *cerebrum*, the anterior grand division, and the *cerebellum*, the posterior grand division, have slight and indirect connection. In form and division of parts, and arrangement of white and grey matter, there is no resemblance. There is here nothing of that symmetry and correspondence of parts which is so remarkable betwixt the right and left portions.

After observing the great divisions of the brain, the distinctions observable in its substance demand our attention. All the outer surface of the cerebrum and cerebellum is of a grey or cineritious colour. Certain central spots of the cerebrum and cerebellum present the same appearance. The ganglions have also cineritious coloured matter in their composition; it is found in the spinal marrow and in some of the nerves.

Encompassed by the grey cortical matter, there is a large central portion of white matter, commonly called the medullary substance of the brain. This white substance is striated, and the striæ have a regular order.

First grand order of striæ. — The striæ which first attract attention are those which run across from side to side of the brain: they form the media of communication betwixt the two lateral divisions.

In the cerebrum, we find these striæ converging from the circumference towards the centre, and accumulated in the centre to form the great commissure. In the cerebellum, the same convergence takes place, and the commissure formed, is what is called the pons varolii.

Second grand order of striæ. — From the inner surface of the cineritious or cortical matter, striæ of medullary matter descend towards the base of the brain. They converge as they descend; and the striated structure becoming more distinct and more resembling the nerves, they at last appear extricated

from the covering of the cineritious matter, and are what we call the CRURA CEREBRI and CRURA CEREBELLI.

As the crura cerebri are formed by the descending striæ of the cerebrum, so are the crura cerebelli formed by the descending and converging fibres of the medullary matter of the cerebellum. Certain cineritious masses (insulated from the great cortical mass of the same colour) are observable in the course of these medullary striæ: these masses have hitherto received the names, CORPORA STRIATA, THALAMI NERVORUM OPTICORUM, CORPORA DENTICULATA, CORPUS NIGRUM, &c.

If we continue to trace the crura of the cerebrum we shall find them still converging and assuming a smaller diameter and passing under the commissure of the cerebellum (or pons varolii), and joining to the crura cerebelli they are prolonged into the portion called MEDULLA OBLONGATA, and this last portion contracting again is continued into the SPINAL MARROW OF MEDULLA SPINALIS. The *medulla spinalis* has a central division, and also a distinction into anterior and posterior fasciculi, corresponding with the anterior and posterior portions of the brain. Further, we can trace down the crura of the *cerebrum* into the anterior fasciculus of the spinal marrow, and the crura of the *cerebellum* into the posterior fasciculus.

Since the time of Galen down to Cuvier, anatomists have been in the use of describing the medullary matter as descending and passing out to form the medulla oblongata. But there are some authors in the present day who choose to consider the matter as entirely the reverse; the spinal marrow they would describe as the trunk from which the brain expands, and they trace the different divisions of the brain from the several cords or columns of the spinal marrow. What is there in the spinal marrow that it should constitute that root from which the brain is formed. The spinal marrow consists of the nervous centre which orders the actions of respiration, and besides this, it is nothing but the cord of nerve

leading to the inferior parts of the body. There is nothing here then, which should in an especial manner be connected with the encephalon or organ of the mind. On the other hand, philosophers say truly that the powers of the mind are developed through the organs of the senses, and if we consider how closely related the operations of the mind are to the impressions received through the nerves of sense, we must be inclined to trace these nerves into the base of the brain, and look for the principal organ of the brain by following the tracts of these nerves into its substance. Comparative anatomy will exhibit the nerves of the senses with the organs of the senses at their further extremities, and the ganglia at their nearer extremities: and when these ganglia run together, they constitute the brain. We ought to enquire what parts of the brain continue to enlarge as the organs of the senses expand, and what parts of the brain bear no correspondence with the change of the organs of the senses. Surely that part of the brain, the developement of which corresponds with the nerves of sense, must be directly connected with them. But if there be portions of the brain which are evolved, and increase, and finally assume the form and size of the cerebrum and cerebellum of the human head; and if these bear no relation at all to the developement of these organs of sense, whilst they bear an intimate correspondence with the developement of the powers of the mind: the natural conclusion is, that they constitute the higher and more important parts of the brain.

## OF THE CINERITIOUS MATTER OF THE BRAIN.

Physiologists have been mistaken in supposing it necessary to prove sensibility in those parts of the brain which they are to suppose the seat of the intellectual operations. We are not to expect the same phenomena to result from the cutting or tearing of the brain as from the injury to the nerves. The

function of the one is to transmit sensation; the other has a higher operation. The powers of the organs of sense are different; the sensibilities of the parts of the body are very various. If the needle piercing the retina during the operation of couching give no remarkable pain, except in touching the common coats of the eye, ought we to imagine that the part which is the seat of the higher operations of the mind should, when injured, exhibit sensibility, when the nerve of vision does not? So far therefore from thinking the parts of the brain which are insensible, to be parts inferior (as every part has its use,) I should even from this be led to imagine that they had a higher office. And if there be certain parts of the brain which are insensible, and other parts which being injured shake the animal with convulsions, exhibiting phenomena similar to those of a wounded nerve, it seems to follow that the latter parts which are endowed with sensibility like the nerves, are similar to them in function and use; while the parts of the brain which possess no such sensibility are different in function and organization from the nerves, and have a distinct and probably higher operation to perform.

If in examining the structure of the brain, we find a part consisting of white medullary striæ, and fasciculated like a nerve, we should conclude, that as the use of a nerve is to transmit sensation, not to perform any more peculiar function, such tracts of matter are media of communication, connecting the parts of the brain; rather than the brain itself, and the seat of mind. On the other hand, if masses are found in the brain unlike the matter of the nerve, and which yet occupy a place guarded as organs of importance, and holding evidently important relations, we may presume that such parts have uses different from that of merely conveying sensation; we may rather look upon such parts as the seat of the higher powers.

Again, if those parts of the brain which are directly connected with the nerves, and which resemble them in structure, give pain when injured, and occasion convulsion to the animal as the nerves do when they are injured; and if on the contrary such parts as are more remote from the nerves, and of a different structure, produce no such effect when injured, we may conclude, that the office of the latter parts is more allied to the intellectual operations, less to mere sensation.

When we compare the structure of the brain in different animals we find that in certain lower classes there are no convolutions, the surface of the cineritious matter is uniform. As we ascend in the scale of beings we find the extent of the cineritious matter increased. To admit of this, it is convoluted; the depth of the sulci are the consequence of the extension of the cineritious mass; and in man above all other animals are the convolutions numerous and the sulci deep, and, consequently, the cineritious mass great, and its extension of surface far beyond that of all other creatures.

Another circumstance which points out the importance of the cineritious matter of the brain is, that every portion has a fibre of medullary matter which runs across and forms a commissure with the corresponding portion of the opposite side.

Unless the cineritious masses were important organs, why should there be commissures or nerves forming a distinct system arising and terminating in nothing? But if we take them as commissures, *i. e.* bonds of union betwixt the corresponding sides of the great organ of the mind, we at once perceive how careful nature is to unite the two lateral organs together, and out of two organs to make ONE MORE PERFECT.

If we grant that this cineritious matter of the brain is an organ or organs of importance, then we may also acknowledge that the portions or masses of cineritious coloured matter which we discover in re-

mote parts of the nervous system, minister to some similar important office. The ganglia have all cineritious matter in their composition; and there are portions of cineritious matter found in the crura or processes of the brain, and in the spinal marrow.

I have found at different times all the internal parts of the brain diseased without loss of sense; but I have never seen disease general on the surfaces of the hemispheres without derangement or oppression of the mind during the patient's life. In the case of derangement of mind, falling into lethargy and stupidity, I have constantly found the surface of the hemispheres dry and preternaturally firm, the membrane separating from it with unusual facility.

From these considerations I must conclude, that the cineritious matter of the brain is the seat of intellect, and the medullary the subservient parts.

At first it is difficult to comprehend, how the part to which every sensation is referred, and by means of which we become acquainted with the various sensations, can itself be insensible; but the consideration of the wide difference of function betwixt a part destined to receive impressions, and a part which is the seat of intellect, reconciles us to the phenomenon. It would be rather strange to find, that there was no distinction exhibited in experiments on parts evidently so different in function as the organs of the senses, the nerves, and the brain. Whether there be a difference in the matter of the nervous system, or a distinction in organization, is of little importance to our enquiries, when it is proved that their essential properties are different, though their union and cooperation be necessary to the completion of their function, viz. the developement of the faculties by impulse from external matter.

## OF THE CEREBELLUM.

Although the cerebellum be composed of the same nervous matter with the cerebrum, and although there be here also the distinction of cineritious and medul-

lary matter, yet in form and in internal arrangement it is quite unlike the cerebrum.

Betwixt the lateral portions of the cerebrum there is a strict resemblance, and an intimate connection is preserved by the commissures; that is to say, every part is united by transverse tracts of medullary matter, and there is every provision for their acting with perfect sympathy.

On the contrary, the cerebrum, which is the anterior grand division of the brain, and the cerebellum the posterior grand division, have slight and indirect connection. In form and division of parts, and in the arrangement of white and grey matter, there is no resemblance betwixt them; therefore there is nothing of that symmetry which is so remarkable in comparing the sides of the brain. There cannot therefore be a correspondence in their functions.

We have already explained that the cerebrum has connection with the anterior columns of the spinal marrow, and the cerebellum with the posterior columns. And no one has given reason to doubt the correctness of the statement that I have made, that the anterior column is for motion, and the posterior for sensibility. If we were to indulge in opinions which we could not bring to the test of experiment, we should say that the cerebrum had power over the motions of the body, and the cerebellum over its sensibility. This only I know for certain, that the destruction of the hemisphere of the cerebrum destroys the motion of the corresponding part of the body; but I have seen no decided proof that the injury of the cerebellum destroys the sensibility of the corresponding part of the body. I have no doubt that we shall find out the functions of these different parts of the encephalon, although the experiments made hitherto have been rude and unsatisfactory.

### OF THE MEDULLA OBLONGATA.

Although the medulla oblongata is in our system-

atic works always termed one of the three great divisions of the brain, it is in truth no more than the medullary matter which we trace from the cerebrum and cerebellum into the spinal marrow. If we speak of the spinal marrow as a column of nervous matter, the medulla oblongata resembles the ornamented capital of that column.

Looking to future improvement, the great desideratum in the investigation of the brain, is to ascertain which are the essential and fundamental parts, and which are the superadded parts; and in the next place to determine what is the difference produced on the arrangement of these parts, in consequence of the animal possessing a spinal marrow.

The formation of the spinal marrow requires an entire change in the arrangement of the nervous system, both brain and nerves. When there is a spinal marrow there is a cerebellum, but none without it. From the cerebrum and cerebellum go down processes, to form the spinal marrow. When a spinal marrow is given, there is a regular series of nerves, arising from it by double origins. To what then is owing this remarkable change in the arrangement of the nerves? To the possession of a regular apparatus for respiration; the respiration by ribs, abdominal muscles, and diaphragm, requires that distribution of nerves which is bestowed through the spinal marrow, and thus influences the arrangement of the whole nervous system.

In the lower animals, in insects, worms, and snails, there is a nervous thread extending from one ganglion to another, in all their length. There is nothing which, by its magnitude, would indicate a *brain*; for the ganglion in the head is smaller than the ganglions in the body. Linnæus said, insects have no brain. But wherever there is concatenated motion, there is a brain, as in the nervous system of the caterpillar, the worm, or the slug. If we cut off the anterior ganglion, it will be found that the direction of motion is lost. If a worm be divided, it will have abundant

motion in the posterior division; but the anterior division is possessed of the power of combining, which enables it to remove itself from the injury: the anterior portion will move away, while the posterior twists itself in the same spot. The nervous system of insects is full of interest, as we see an exact adaptation of the nerves to the organs and muscles, and a dependence of the brain upon the arrangement of the nerves. It is interesting to see, in the change from the larva to the winged state, how the brain, ganglions, and nerves accompany these changes of the organs of motion.

Notwithstanding that the brain in the lower creatures is distinguished as the source of volition, in them it is not of the same value to life as in the higher animals. In man it is not only beyond calculation great in its appropriate energies, but, as a vital part, it is of the first class, and second only to the stomach.

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## OF THE MEMBRANES OF THE BRAIN,

AND

## OF THE SUBSTANCE AND TEXTURE OF THE BRAIN ITSELF.

### OF THE DURA MATER.

Many authors, while they describe the cranium as containing the brain, conceive that it also gives it shape. But the brain is formed before the bones which invest it. The first thing that we observe in the embryo is the disproportionate size of the brain to the diminutive body. The ossification of the bones of the skull is a gradual process. The brain, already formed, is invested with the strong membranes; and betwixt the laminæ of the outer membrane the points of ossification commence, and are not completed until the ninth year. The bony matter, which is deposited betwixt the layers of this membrane, retains a firm

connection and interchange of vessels with the now apparently distinct membranes on its inner and outer surfaces. The outer layer, which is so strong in children newly born, becomes the delicate pericranium, whilst the inner layer is the dura mater. Thus we find that the bones of the head are moulded to the brain, and the peculiar shapes of the bones of the head are determined by the original peculiarity in the shape of the brain.*

This view corrects an error into which many have fallen, that the dura mater and the vessels ramifying upon it impress their form upon the solid bones, and wear channels upon their surface by their incessant pulsation. The membranes and vessels precede the formation of the bone, and the osseous matter is deposited so as to be moulded round the vessels. †

Thus the dura mater may be considered as the internal pericranium. ‡

The dura mater § is a firm opaque membrane of considerable thickness. — When the skull-cap is torn off, and it is cleaned from the blood which escapes from the ruptured vessels, it is seen marbled with azure and rosy colours. Its outer surface is rough, from the adhesions to the bone being torn up : but on the surface lying in contact with the brain, it is smooth, shining, and of a pearl colour.

* Certainly the skull is adapted to the form of the brain. But there is a deeper question which our craniologists have forgotten. Is the brain constituted in shape with a reference to the future form of the head? No doubt it is.

† Albini Acad. Anat. "Quomodo cranium crescendo accommodat se eis quæ continet."

Fischer, Dissertatio de modo, quo, ossa se vicinis accommodant partibus.

‡ Some regard only its external lamina as the internal pericranium. Haller, t. iv. p. 92. Fallopius first viewed the dura mater in this light, and he is followed by the best anatomists.

§ The membranes of the brain have the name of *mater*, because they defend the brain, and protect its tender substance; or, according to some anatomists of the Arabian school, because the other membranes of the body are produced from them. Before Galen, the term Meninx was common to all the membranes of the body, afterwards it was appropriated to those of the brain.

Although the dura mater is really the strongest membrane of the body, it is yet divisible into laminæ; these are firmly connected by the intertexture of strong fibres. Most anatomists describe it as composed of two laminæ.* Some, however, describe three laminæ: the outer lamina, or squamosa; the middle, or filamentosa; and the internal (being smooth and uniform), the lamina membranosa.† But to separate the dura mater into such laminæ, it will, I believe, be necessary to dry it and tear it into shreds. No doubt it may be possible thus to tear it, as some have done, into four, six, seven, or even eight laminæ or squamæ. It is to be regretted that anatomists should have been proud of such dissections.

The dura mater is insensible, as we prove by the operation of trepan; it has, in the way of experiment, been pricked and injured by every possible contrivance, by mechanical and by chemical stimulants; yet the animals, the subjects of such cruel experiments, have given no sign of pain.‡ Before the fact of the insensibility of the dura mater was thus established, physicians regarded this membrane as the seat and origin of many diseases.§

Formerly the natural connection of the skull and dura mater was so resolutely denied, so hotly contested among the various parties in anatomy and surgery, that we might, by reading their disputes, almost doubt one of the plainest and most obvious facts, were not the closeness of this connection sufficiently

* Soemmerring Corp. Hum. Fabrica, t. iv. p. 26. Haller, t. iv.

† Malacarne, p. 22. It is described as partly tendinous, partly ligamentous; that is to say, of a nature resembling these, yet not altogether the same. Vicq d'Azyr found it separated by purulent matter into two laminæ, the fibres of which had a different direction. Acad. des Sciences, An. 1781, p. 497. — Bartholin Sp. Histor. Anatomiæ.

‡ Zinn. Exper. circa corpus callosum, cerebellum, duram meningem. — Mém. par Haller sur les Parties sensibles et irritables. — Blegny, Journal de Méd. An. 1. p. 16.

§ See Hoffman. Med. Ration. part 2. sec. ii. c. 1. § 2. and Boneti Sepulch. Anat. lib. i. sec. i.

proved by the manner of the original formation of the cranium, and by the bleeding surface of the dura mater when the bone is raised.; or, if further proof be required, we may macerate these bones and their membranes in acids, when the laminæ of the dura mater will be seen intimately connected with the bone, while the pericranium and outer laminæ of the dura mater are seen to be continued into each other *, by the intermediate cellular texture in which the earth of the bones was lodged. †

The dura mater adheres more firmly to the bone in young subjects, because the bone is yet imperfect, and its surface spongy and rough ; and for the same reason, it is more firmly attached to the skull in the chronic hydrocephalus, because the ossification is imperfect. It frequently adheres so firmly to the skull-cap, as to leave its outer lamina adhering to the skull when it is raised.

### GLANDS OF THE DURA MATER.

Upon the external surface of the dura mater there are little holes, from which emerge fleshy-coloured papillæ, and which, upon examining the skull-cap, will be found to have corresponding foveæ. These are the glandulæ Pacchioni. ‡ They are in number from ten to fifteen§ on each side, and are seen chiefly lateral to the course of the longitudinal sinus. These bodies were supposed by Pacchioni to be glands. When pressed, they gave out a fluid ||; but in this

* Vicq. d'Azyr, Mém. de l'Acad. Roy. 1781, p. 497, and Malacarne (Aderenze della D. M. alle pareti interne del cranio), p. 24.

† Taking a portion of the dura mater betwixt the finger and thumb, we can move the two laminæ upon each other, owing to a slight degree of laxity in the connecting cellular substance. This cellular texture is demonstrated by Malacarne, by forcibly injecting quicksilver betwixt the layers of the membrane.

‡ See M. Littre Acad. Roy. des Sciences, 1704. Hist. p. 32. art. 19.

§ Haller, El. Phys. p. 106. Mém. par M. Vicq d'Azyr. Mém. de l'Acad. Roy. 1781, p. 497.

|| Malacarne.

they do not differ from the loose common cellular membrane. As they are chiefly seen along the line of the great sinus, and are not scattered over the whole dura mater, their supposed use of moistening the surface of the membrane * is quite improbable; and, indeed, this is a part of that unfounded hypothesis which supposed an interstice betwixt the dura mater and skull, and ascribed independent motion to this membrane. The surfaces of the dura and pia mater, where they are in contact, being of the nature of the secreting surfaces of the investing membranes of the other viscera, require no such further aid in moistening them, or preventing their adhesion. Many glands are described by authors in the substance, and upon both surfaces of the membrane. Of the bodies which adhere to the surface of the pia mater, and of those also which are to be seen in the sinuses, we shall speak afterwards, when considering the veins which enter the longitudinal sinus.

## ARTERIES OF THE DURA MATER.

This membrane must necessarily be supplied with vessels for its own nourishment, for that of the contiguous bone, and for the perpetual exudation of the fluid which moistens or bedews its internal surface. We may divide the arteries of the dura mater into anterior, middle, and posterior. The first proceeding from the ophthalmic and ethmoidal branches of the internal carotid; the second from the internal maxillary and superior pharyngeal; the posterior from the occipital and vertebral arteries and posterior auris. †

The principal artery of the dura mater, named, by way of distinction, the great artery of the dura mater, is derived from the internal maxillary artery, a branch of the external carotid. It is called the spinalis, or

* Viz. the opinion of Fantonius.

† Soemmerring, C. H. Fabric. A. Murray, Descrip. Arteriarum, in tab. redact.

spheno-spinalis, from its passing into the head through the spinous hole of the sphenoid bone; or meningea media, from its relative situation, as it rises in the great middle fossa of the skull. This artery, though it sometimes enters the skull in two branches *, usually enters in one considerable branch, and divides soon after it reaches the dura matter into three or four branches, of which the anterior is the largest; and these spread their ramification beautifully upon the dura mater, over all that part which is opposite to the anterior, middle, and posterior lobes of the brain. Its larger trunks run upon the internal surface of the parietal bone, and are sometimes, for a considerable space, buried in its substance. The extreme branches of this artery extend so as to inosculate with the anterior and posterior arteries of the dura mater, and through the bones (chiefly the parietal and temporal bones) they inosculate with the temporal and occipital arteries. †

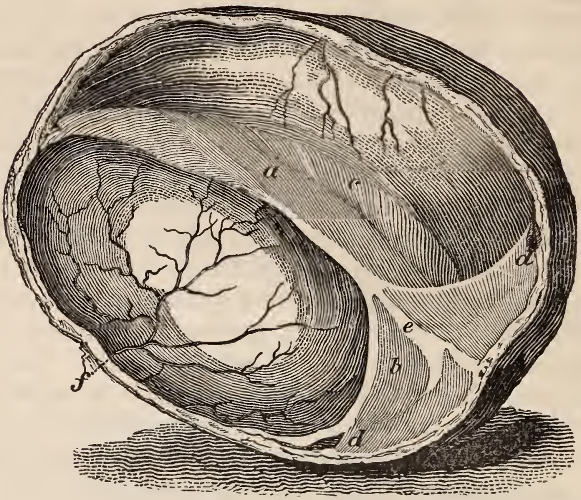
The meningeal artery has been known to become aneurismal and distended at intervals; it has formed an aneurism, destroying the bones, and causing epilepsy. ‡

* Soemmerring de Corp. Hum. Fab. tom. v. p. 142. This is not the sole artery sent to the dura mater from the internal maxillary: a twig also rises from that branch which goes to the pterygoid muscles and parts about the Eustachian tube — it enters the scull, and is distributed to the fifth pair of nerves, and to the dura mater and cavernous sinus; another enters with the inferior maxillary nerve by the foramen ovale, and rises upon the dura matter.

† Malacarne. — Soemmerring, tom. v. p. 142.

‡ Malacarne, p. 1. sec. 105.

THE SKULL-CAP, WITH THE DURA MATER ADHERING.




(*a*) Falx — (*b*) Tentorium —(*c*) Longitudinal sinus — (*d d*) Great lateral sinuses — (*e*) Fourth sinus — (*f*) Artery of the dura mater.

## OF THE SEPTA WHICH INTERSECT THE BRAIN.

Those septa, or, as they are called, processes of the dura mater, being extended across from the internal surface of the cranium, support the brain in the sudden motions of the body, and prevent the gravitation of its parts; but I believe they are chiefly useful in retaining the sinuses in their triangular form.

These partitions are formed by the reflection of the internal lamina of the dura mater.

The falx is the largest of the partitions; it is attached to the cranium in the line of the sagittal suture, and reaching from the crista galli of the ethmoid bone to the middle of the tentorium, or to the crucial ridge of the occipital bone, it passes deep iuto the middle of the cerebrum, and divides it into its two hemispheres, It is in shape like a scythe, for anteriorly it does not pass so deep into the substance

of the brain; but it gradually becomes broader, or descends deeper betwixt the hemispheres, as we follow it backwards, which, with the curve it necessarily takes from the shape of the cranium, has obtained it the name of falx: it is also called septum sagittale, verticale, or mediastinum cerebri.*

The TENTORIUM separates the cerebrum and cerebellum. It stretches horizontally over the cerebellum, and sustains the posterior lobes of the cerebrum. It is formed by the inner lamina of the dura mater, reflected off from the os occipitis along the whole length of the grooves of the lateral sinuses, and the edge or angle of the temporal bones. This septum, thus running round the cavity of the cranium, divides it into two departments; the upper one for the lodgment of the cerebrum, and the lower for the cerebellum. But to allow the union of these two great divisions of the encephalon, a circular opening is left upon the anterior part of the tentorium, which is called the notch of the tentorium.

There is a little process of the dura mater, which may be called the FALX of the CEREBELLUM. It runs down upon the internal spine of the occipital bone from the tentorium, gradually contracting until it terminates on the margin of the great occipital foramen. It serves as a kind of ligament strengthening the tentorium, while it divides the cerebellum. It enters, however, but a little way betwixt the lobes.

The falx and tentorium being connected and continued into each other at their broadest part, they mutually support each other, and are quite tense. This tenseness depends on their mutual support, for when one of them is cut the other falls loose.†

The lateral extremities of the tentorium are continued forward into acute lines, formed by the duplicature of the dura mater coming off from the edges of the pars petrosa of the temporal bones, and take

* The falx has not been found in some subjects. Garengeo Splanchnologie. Mr. Carlisle, Medical Transactions, 1793.

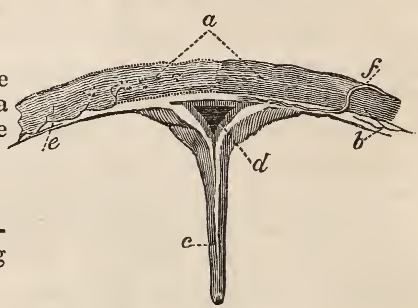
† Monro.

firm hold on the posterior clynoid processes. From these two points a fold of the membrane stretches forward on each side to the anterior clynoid process, forming thus a hollow or cell for the lodgment of the pituitary gland. Another fold or duplicature of the dura mater, runs onwards a little way from the edge of the little wing of Ingrassias. These are the SPHENOIDAL FOLDS.

Where the internal lamina of the dura mater forsakes the external to form the falx and tentorium, it leaves a channel or triangular canal; the basis of which triangle is the lamina of the membrane investing the cranium, while the tension of the partitions carries the apex out into an acute point. This forms a channel for receiving all the blood of the veins, and this tension and triangular shape gives a degree of incompressibility to the canals. These are the sinuses which receive the veins of the encephalon, and guard them from compression:—

SECTION OF THE LONGITUDINAL SINUS.

(*a.*) The skull.
(*b.*) The dura mater.
(*e.*) The extremities of the artery of the dura mater passing into the bone.
(*c.*) The falx.
(*d.*) The sinus.
(*f.*) A branch of the temporal artery passing into the dura mater.




Upon the surfaces of the dura mater there are many lacerti, or slips of fibres, which are interwoven with the membrane, so as to strengthen it. These fibres are peculiarly strong in the angles, where the duplicatures pass inwards, giving firmness to the sinuses, while they allow the veins to insinuate their trunks betwixt them; these fasciculi or slips of fibres, on the sides of the sinuses, are the cordæ Willisianæ.

They were considered by Baglivi and Pacchioni * as the tendons of the muscles of the dura mater, Pacchioni conceiving that this membrane was muscular. Vicq d'Azyr observes, that in inflammation of the dura mater he has seen it red, and of a fleshy appearance; and that such a circumstance might have deceived Pacchioni, and made him believe that there were muscular bellies. †

These physicians conceived that the contraction of the falx and dura mater raised the tentorium; they even conceived that the action of the heart depended upon this motion of the dura mater.‡ They were deceived by the pulsation in the arteries of the brain, communicated to the dura mater, after the operation of trepan, or in their experiments on living animals. §

The motion communicated to the dura mater, those Italian anatomists conceived to depend on the rising of the tentorium. This motion, which is occasioned by the beating of the arteries of the brain, had been long before observed ||: some conceived it to be a motion on the brain itself, others believed it to depend on the sinuses.¶

* These were Italian anatomists. Pacchioni was physician to Clement the XIth.

† Mém. de l'Acad. Roy. 1781.

‡ Duverney.

§ There is a distinction in the movement of the dura mater to be observed upon opening the skull; one depending upon the pulsation of the arteries of the brain; the other caused by an obstruction to the exit of blood from the cranium, depending upon the lungs. " On voyoit bien la pulsation des artères du cerveau, " qui communiquoient quelque mouvement à la dure-mère, mais ce " mouvement n'avoit aucune symétrie avec celui de la respir- " ation. Fatigué de ne rien voir après avoir si bien vû, je compri- " mai la poitrine de l'animal: aussitôt le cerveau si gonfla, evidem- " ment par le reflux du sang de la poitrine qui remplissoit la jugu- " laire.—Je lachai la poitrine, et le cerveau redescendit."—Exper. 78. Mém. ii. par Haller sur le Mov. du Cerv.—" Il arrivoit, pour- " tant, de tems en tems, et sans que cela continuât, que le cerveau se " soulevoit dans l'expiration, et se laissoit repomper dans l'inspir- " ation." Exper. 79. s. chat.

|| By Coiterus, Riolanus, Bartholin.

¶ Diemerbroek.

The motion caused by respiration was likewise observed.* M. de Lamure's conclusion was, that the motion of the brain was caused by the reflux of the blood towards it from the vena cava in expiration.† He undertook to demonstrate this; and he conceived his proof to be good, when, by pressing the ribs of a subject, he saw the refluent blood swelling the jugular and abdominal cava. Haller observed the jugular veins swell, and become turgid, during expiration; and he concluded, that the motion of the brain was occasioned by the refluent blood distending the sinuses of the brain. But he did not believe, as Lamure did, that this motion took place before the opening of the cranium, as well as after it.

When the skull is opened by a wound, the dura mater still protects the brain, resisting inflammation, and giving the necessary and uniform support to the more delicate substance and vascular membrane of the brain; but when the dura mater is lacerated by the trepan, or punctured, or worn by the pulsation against the edge of the bone, there may be sudden hernia of part of the brain from coughing, or a rapid and diseased growth from the pia mater forming a fungus tumour. This fungus is occasioned by the taking away of that compression which the resistance of the dura mater gives when entire ‡; for by this yielding at a point, the whole force of the circulating blood is directed to it.

### OF THE TUNICA ARACHNOIDEA.

While the dura mater is closely connected with the cranium, and in contact with the surface of the brain, but still unconnected with it, (except by means of veins entering the sinuses, and that only

* M. Schlichting Mém. des Savans Etrangers, 1774. Larry, Mém. present. à l'Acad. des Scien. par divers Savans Etrangers.

† M. de Lamure; vide l'Acad. des Sciences, 1744.

‡ I have seen in one day seven wounds of the head with fracture; of these, three had the bones thrust through the dura mater, and they died with fungus cerebri; the four others did well.

in the course of the sinuses) the pia mater is closely attached to the brain, and passes into its inmost recesses. While the dura mater is firm and opaque, and not prone to inflammation, the pia mater is delicate, transparent, extremely vascular, and most peculiar in being easily inflamed. * Like the dura mater it is not endowed with sensibility †; it is of great strength, considering its apparent delicacy. ‡

The pia mater, which was formerly considered as a simple membrane, consists, in reality, of two membranes, the TUNICA ARACHNOIDEA, or meninx media, and the proper pia mater, or tunica vasculosa. §

The TUNICA ARACHNOIDEA was discovered and commented upon by a society formed by Blasius, Sladus, Quina, and Swammerdam. ‖ They called it Arachnoides, because of its extreme tenuity, comparing it to a spider's web. It was called also Membrana Cellulosa, from the appearance it took when they insinuated a blow-pipe under it, and blew it up, separating it from the pia mater. ¶

This membrane is without the pia mater; and while the pia mater sinks down into the sulci of the brain, this covers the surface uniformly, without passing into the interstices of the convolutions, or into the ventricles. **

This membrane is so extremely thin, that it cannot by dissection be separated for any considerable space from the pia mater, and, least of all, over the middle hemisphere of the brain. By the blow-pipe, indeed, we may raise it into cells, but it immediately subsides

* Mr. Hunter on the blood.

† Haller. Oper. Minor. de Part. Corpor. Humani sent. & irrit.

‡ Sir C. Wintringham, Exper. Essays. Taken comparatively it is stronger than the aorta.

§ There are many, however, who with Lieutaud consider the arachnoid coat as the external lamella of the pia mater.

‖ This was in 1665. I am, perhaps, not correct in saying they discovered it, for Varolius describes it plainly, covering the medulla oblongata.

¶ Ruysch Tab. 10. Epist. Anat. Prob. viii.

** Haller. Elem. Phys. tom. iv. sec. viii. p. 7.

again; on the posterior part of the cerebellum, on the spinal marrow and base of the brain, it separates spontaneously, and is very easily demonstrated.* It does not pass deep into the sulci of the brain, but unites them by an extremely delicate cellular texture.

### OF THE PROPER PIA MATER, OR TUNICA VASCULOSA.

The pia mater is a simple membrane without either tendinous, aponeurotic, or muscular fibres. It is extremely vascular, but it is transparent in the interstices of its vessels; it is the membrane which immediately invests and connects itself with the substance of the brain; and although delicate, it forms the support and strength of the cineritious and medullary substance. All vessels distributed in the body, however minute, are conveyed in membranes; the pia mater, therefore, follows, or rather conveys the vessels not only into the cavities of the brain, but to every part of its substance, it being intimately blended with it.† We see it more distinctly descending in strong plicæ into the interstices of the convolutions; nor is it into them only that it enters, but into every pore which conveys a vessel.‡ The pia mater, as it passes into the substance of the brain, divides and subdivides into partitions and cells, and every capillary vessel, and every mollicule of the substance of the brain, is invested and supported by its subdivisions. The pia mater is to the brain what the cellular membrane is to the other viscera and

* F. Ruyschii Responsio ad A. os Goelecke Epistol. ix. See Bidloo, table 10; but the membrane is so delicate that it can be but very imperfectly represented by engraving. See also Sandifort Thesaur. vol. ii. p. 291.

† Columbus, the assissant of Vesalius, and afterwards professor in Rome, explained this intimate intertexture of the pia mater with the proper substance of the brain, so far back as 1559.

‡ When we tear off the pia mater from the brain (for it cannot be called dissection), it does not adhere merely at the sulci, but to the whole surface of the convolutions; and every where small vessels enter, and with these vessels descends also the lamina of the pia mater.

parts of the body; for it is the peculiar matter lying in the interstitious cellular membrane (as in muscles, bones, &c.) that gives the peculiarity of character to the parts *; the cellular membrane itself is nearly alike in all; therefore, in my judgment, the pia mater is properly enough considered by anatomists as a cellular substance.†

Malacarne says, I am much inclined to consider it with the illustrious Haller, as being composed of laminæ like common adipose membrane, and that the extreme arteries ramify through its cells, for, with a blow-pipe, we can raise it into cells like the common membrane; and if this be carefully done, the air may be made to pass from cell to cell, following the arteries in their course betwixt the lobuli, and in the substance of the brain.‡ We can follow the pia mater into the ventricles, by tracing it betwixt the posterior lobe of the cerebrum, and the cerebellum, where it forms the velum interpositum of Haller, and passes under the fornix. We can follow it also into the posterior horn of the lateral ventricles from the base of the brain, where the branches of the middle artery of the cerebrum pass into the lower part of the choroid plexus; we trace it also into the bottom of the fourth ventricle. The pia mater lining the ventricles, is more delicate, and less vascular than that seen upon the surface, and betwixt the convolutions of the brain.

It has been said that the ventricles of the encephalon served to increase the surface of the pia mater, and that whatever purposes are served by that membrane and its vessels on the surface of the brain,

* See Leeuwenhoek, Epist. Phys. xxxiv.

† Bergen. Program. de Pia Mater. See Haller Anat.

‡ See Albinus Ann. Acad. vol. i. lib. i. cap. xii. and the beautiful plate iii. See Ruysch. tab. 8. Epist. Anat. vii. & tab. 15. Such is the profusion of vessels distributed to inconceivable minuteness, that it has been considered as entirely composed of vessels; it has received the name of chorion, from the membrane of the secundines, Galen de Usu Part. l. viii. cap. 8. Malacarne, part. i. sec. 243.

we must suppose the same performed by it within the ventricles. * This seems more like a satisfactory conclusion than it really is.

As the tunica arachnoidea is of a peculiar nature, and has few, if any, vessels, and as it covers the external surface of the brain only, it seems to me probable that this membrane is the cause why effusions in the ventricles are so common, and why fluids are so seldom found betwixt the surface of the brain and the dura mater. When by the diseased action of the vessels of the pia mater on the surface of the brain, an effusion is thrown out, it very seldom lies unconfined upon the surface; but frequently fluids are contained in sacs of the arachnoid coat, betwixt the convolutions of the brain, or raise pellucid vesicles upon the surface. The want of a tunica arachnoidea upon the pia mater of the ventricles, may be a cause of the fluids being so much more readily secreted into these cavities.

The raising of the arachnoidea into vesicles by the action of the vessels of the pia mater, is rather an argument for the distinct nature of these membranes. The tunica arachnoidea is raised by the action of the vessels of the pia mater, as the cuticle is raised into blisters by the inflammatory action of the vessels of the cutis, while no other membranes of the body present such an appearance in their disease. They inflame, indeed; they thicken; their laminæ become more distinct, or their cellular substance fills with water, or hydatids are formed in them; but this appearance of water secreted under the tunica arachnoidea is peculiar to the surface of the brain.

## OF THE SUBSTANCE OF THE BRAIN.

The cerebrum and cerebellum consist, as we have said, of two substances very different in colour, viz. the cineritious and medullary matter, first described by Picolomini. The cineritious, or ash-coloured matter, forms the superficial or outer part of the en-

* Dr. Monro's Nervous System, chap. vi.

cephalon, and is therefore called also the cortical part. This cortical matter is of a reddish grey colour, and simitransparent, but varies considerably *; in the crura cerebri it is very dark; in the pons varolii it is redder; in the corpora olivaria † it is yellower. The consistency of this matter also varies considerably in different parts: it is soft in the base of the brain, betwixt the optic nerves and anterior commissure, and in the third ventricle. The medullary matter is chiefly in the internal part of the brain, forming a kind of nucleus or white central part; but in many parts of the brain, there is a mixture of these which form striæ ‡; and in some of the eminences, the internal part is cineritious, while the external part, or what we might here call the cortical part, is medullary.

The cortical or cineritious substance does not blend gradually with the white medullary matter, but on the contrary, their line of distinction is abrupt: and even an intervening substance has been observed. In inflammation of the brain, particularly, it has been said, that this third substance has been found. This may be merely the effect of light upon the union of the two substances. We, however, often observe an appearance of successive coloured circles

* Cuvier describes it black in some places.

† Vicq d'Azyr.—"Exterior cerebri totius facies, donec in spinalem medullam abeat, plerumque colore est subrubride cinereo "vel languide russeo. Fusciora sunt cerebra sanguine ditia, *e. g.* "hominum apoplexia enectorum, vel hominum crassioris sanguinis; "pallidissima vero sunt cerebra hydropica vel hominum pituitosorum vel hæmorrhagia mortuorum. Dubior procul color cerebri "sanguinis temperaturam sequitur, et ideo pallidius est infantibus, "quam adultis." Soemmerring Hum. Corp. Fab. vol. iv. p. 41. As Boerhaave never saw, or observed, but merely imagined, he ought not to be regarded; now we may look for a better purpose into Albinus. Annot. Academ. vol. li. c. 12.

‡ Thus the cineritious substance is mixed with the medullary matter in the corpus callosum, in the corpora striata, the thalami nervorum opticorum, in the tubercula quadrigemina, the emminentia mamillaria; in the crura cerebri; in the pons Varolii; in the corpora olivaria, and medulla spinalis.

upon the edge of the medullary matter of the arbor vitæ, in the cerebellum.

It has been asserted by M. Ludwig * that the masses and striæ of the cineritious substance, dispersed through the internal parts of the brain, have a communication with each other. This, however, is denied, by Vicq d'Azyr.† He conceives, that the cineritious substances of the pons varolii, or of the corpora olivaria, have no communication with the cineritious substance in any other part of the brain; and that in several parts of the brain the cineritious substance is surrounded and isolated by the medullary matter. Its great importance (which should never have been doubted) has been deduced from its being so generally found towards the origin of the nerves.‡

The cineritious substance seems to have a greater proportion of blood circulating in it than the medullary substance. Its vessels come by two distinct routes, partly from the extremities of those arteries which appear in large branches upon the surface of the brain, and partly by vessels which penetrate through the medullary substance from the base of the brain. Ruysch and Albinus have made the most minute injections of this part of the brain. The former conceived it to consist entirely of vessels; but Vicq d'Azyr and Albinus found always, in their

* De Cineria Cerebri Substantia. Leipsiæ.

† Hist. de l'Acad. Roy. an. 1781, p. 507.

‡ Il faut que les usages de la substance grise soient très-importans; car, indépendamment de la portion de cette substance que les circonvolutions contiennent, et qui semble appartenir à la masse blanche du cerveau, on en observe des amas plus ou moins considérables près des diverses origines des nerfs: ainsi près de la première et la deuxième paire, sont les corps striés et les couches optiques; la troisième paire est près d'un espèce noirâtre, que je decrirai ailleurs: la quatrième paire fort au dessous des tubercules quadrijumeaux, dont le noyau est composé de substance grise; la cinquième, la sixième, la septième, se trouvent aux environs de la protuberance annulaire, où la substance grise est mêlée avec la blanch; la huitième et la neuvième sont placés près de l'éminence olivarie, où j'ai observé un mélange particulier de substance grise. Mém. de l'Acad. Scien. an 1781. p. 507.

experiments, that a great proportion of it remained colourless after the most minute injection. It is, indeed, very improbable, that so soft a body should be entirely composed of vessels. How, for example, can we suppose the commissura mollis, or cineritious matter on the sides and bottom of the third ventricle, or almost transparent lamina, which we find in some parts, to be composed of vessels? *

The white MEDULLARY SUBSTANCE is a pulpy mass. We observe no peculiarity of structure in it towards the surface of the brain, where it is contiguous to the cortical matter; but towards the origin of the nerves it takes a more fibrous and striated appearance. This appearance of fibres is not owing to any peculiarity in the medullary matter, but to the manner in which the pia mater involves it. The medullary matter, being chiefly internal, has every where through the brain a communication as from the fore to the back part, from the upper part to the base.†

## OF THE MINUTE STRUCTURE OF THE BRAIN.

The opinions regarding the structure of the brain have had a dependence on the general doctrines of the structure of the secreting organs, and it is, of course, connected with the disputations of Malpighi and Ruysch. The doctrine of the glandular nature of the brain, and the belief of the nervous fluid, being a secretion, has, in all ages, formed the basis of the most favourite theories.‡

* The centrical and cortical substance of white blooded animals present no difference of colour. *Cuvier*.

† Meckel found, upon comparing the brains of an European and of a Negro, that the medullary matter differed very much in colour. In the Negro, instead of the whiteness of the European, the medullary matter was of a yellow colour, and nearly like the cineritious matter; he observed, also, that this very peculiar distinction of colour was only to be observed when the section was recently made, and that the darker colour of the medullary matter became fainter when exposed to the air.

‡ Indeed this doctrine of the glandular nature of the brain has descended from Hippocrates—"Caput quoque ipsum glandulas "habet cerebrum, enim est ut glandula album est et friabile," &c.

Malpighi found, on throwing in black and fluid injection, that there remained always particles colourless, and to which the injection did not penetrate. He conceived these to be glandular folicules, and that the cineritious substance of the brain consisted of this folicular or glandular structure, while the medullary matter of the brain was merely the fibrillæ of the excretory duct. This opinion was founded on conjecture, with but a very poor show of experiments. By boiling the substance of the brain in oil, he found it take a granulated appearance, as if formed of small grains, or little glands, as he presumed.*

Such was the received opinion until Ruysch, with a despotic authority, swayed the opinions of physiologists: he alleged, in proof, only his own experiments and preparations, in which other anatomists could not follow nor refute him, and therefore, perhaps, they acquiesced. His most unanswerable and most insulting argument was "veni et vide."†

According to Ruysch, the cortical substance of the brain is entirely vascular, and has no appearance of a glandular or folicular structure; nay, he conceived it to be entirely composed of arteries.‡ This opinion Albinus confuted, and Malacarne observes, though we suppose the extremities of the arteries of the cineritious substance to be more minute than those which are distributed to the microscopal cor-

* "Pedamentum, supra quod posita est philia in qua conservatur "porti cerebri in liquore, quam decoxi in oleo olivarum per "horas, sicuti, facere assolet Dr. Vicussens. Ea autem plane "*mutilis et perversa est preparatis*, nam nihilum quidem vasculosi "visui occurrit post decoctionem in dicto oleo, et quod unusquis-"que tentare potest ita ut inventor neutiquam habendus sit Dr. "Vieussens Sc. quod cerebri cortex nil sit, nisi extremitates vaso-"rum sanguineorum : in ea autem nemo hactenus (quod sciam) me "imitari poterit aut analogum quid fecit." Ruysch. Thes. An. x. No. xxxii.

† "Milites quando hostium adventum audiunt, clament ad arma! "ad arma! sic ego dico hic ad visum ! ad visum!" Responsio ad J. Ch. Bohlium.

‡ Vieussens was latterly of the same opinion, and is accused of plagiarism by Ruysch. Accordingly, we find, that in some parts of his works he describes the glands and ducts of Malpighi.

pusculi of the smallest visible insect, there must still remain some part, which is not composed of vessels; and in regard to the veins of the cineritious substance we may appeal to Albinus, who, from the substance of the brain, finds many veins connected with the arteries of the cineritious substance when he carefully lifts the pia mater. But there is this peculiarity in the distribution of the blood vessels of the brain, that though the cineritious substance be the most vascular, yet, in the medullary matter, we see the vessels with large open mouths, and more distinct than in the cineritious substance. In following the blood vessels from the base of the brain into the medullary substance, we see them distinct, and of considerable magnitude; but when they are about to enter the cineritious substance, they disperse into minute branches. * In the same manner those arteries, which are carried into the sulci of the surface by the pia mater, branch into extreme minuteness before they finally penetrate the cineritious substance. †

Leeuwenhoeck‡ observed, in the cortical substance of the brain, a pellucid, crystalline, and, to appearance, oily matter; he calls this, therefore, the *sub-*

* Leeuwenhoeck saw, in the substance of the brain, but especially in the cortical substance, red blood vessels, but so delicate that he could not comprehend how the globules of the red blood could pass along them; and what appeared more particular, they were of a deeper colour than the red particles themselves; for when seen singly, they appeared to have very little colour. This he explained by an experiment made upon a louse. After it had sucked blood very plentifully, he observed that the blood was broken down by digestion, and conveyed through the limbs here and horns of the creature, so as to make it universally red. So here he conceives that the globules of the blood may be broken down and altered in their shape to enter the minute vessels of the brain.

† Malacarne, Part ii. sect. 18.

‡ He was born in Delft in Holland, 1632, and died 1723. He is celebrated for his microscopical discoveries; his papers are chiefly in the Transactions of the Royal Society of London, about the year 1674.

*stantia pellucida et vitrea.* When he had put a small portion of this under his glass, he saw a fluid, which he at first conceived might have escaped from the globules that were necessarily cut by the knife. This fluid also he found to consist of very minute globules, thirty-six times less than those of the blood.* These small globules he conceived to have probably constituted a fluid, which, during the life of the animal, was moveable, and in vessels, though now in death congealed and fixed.† The colour of the cortical substance he found to depend upon the minute ramification of the vessels which were of a dark brown colour, while, in the medullary part, they were clearer and more transparent. Independently of this distinction of vessels, he could observe little difference in the medullary and cineritious substance; the refraction of the rays of light amongst the transparent globules being the cause of the whiteness of the former.

R. Della Torre‡, in his microscopical observations, describes globuli in the brain; he says, that he saw them floating in a pellucid viscous fluid. But Prochaska § thinks Della Torre must be mistaken in this, for when he took a small portion of the brain, he saw it consisting of innumerable globules, which continued to adhere to each other, even after three months' maceration in water; and thence he concludes, that it could not be as R. Della Torre conceived, that these spherical bodies moved from the brain on towards the extremities of the nerves; nor do these bodies lie imbedded in a glutinous fluid (he continues), but they are connected by the extremely

* Anatomica Contemplatio, 30. Ridley, Anat. Cerebri, cap. xi.

† Among these globules of which the brain is composed, he saw also the globules of the blood, which it was easy to distinguish by their roundness. These red globules he supposes had escaped in consequence of the minute vessels having been cut by the knife.

‡ Nuove Oservaziono Microscopiche, Napoli, 1776.

§ Tract. Anatom. de Struct. Nervorum.

minute and pellucid sepimentæ of the pia mater, and by the vessels which pervade both the cortical and medullary matter, and which nourish as well as support and connect these corpusculi.

Fontana*, on submitting a portion of the medullary matter to the microscope, thought he discovered it to consist of small winding tubes filled with a transparent gelatinous humour. This he chose to call the intestinal substance of the brain.

Prochaska † cannot, from his own observations, determine whether the globular bodies of Della Torre be convoluted vessels, or what they are. R. Della Torre had observed, that they were largest in the cortical part, less in the medullary substance, still diminishing in the medulla oblongata, and least of all in the nerves; but succeeding observations did not support this assertion.‡ Malacarne expresses himself to be nearly of the same opinion in regard to the vesicular structure of the cortical substance of the brain. The minute processes of the pia mater, says he, embrace and support the medullary substance, which is surrounded with a matter of a darker colour, and less distinctly fibrous, but not less essential, and which is composed of corpuscules, that, in figure and arrangement, resemble the vesicles of the pulp of a lemon.

Many authors endeavour to support their conjectures regarding this vesicular structure of the brain by morbid dissection. But in this edition I have thrown out the detail of their opinions, as well as all reference to their authority.

I have given more place to these observations on the minute structure of the brain than in my judgment they deserved, rather to prevent the repetition

* Fontana's Treatise on Poison, and on the Primitive Structure of Animals, translated.

† Professor of Anatomy at Prague.

‡ This was certainly a theoretical deception: it is like the accurate observation of Fracassati, who could distinguish a difference of taste in the medullary and cineritious substance of the brain.

of the folly by such as might conclude they were pursuing an unexplored path, than from any hope of the subject proving useful.

When the brain is examined in the fœtus of the early months, although the substance of the brain is extremely soft, and even of a fluid consistence, the membranes and vessels are fully formed, exquisitely minute, and perfect in all their processes, so that they give form and firmness to the brain. As the brain is perfected, and as it is covered by a firmer bone, it acquires more consistence and firmness. With this firmness it does not acquire strength, for the brain of a child will suffer more injury without destruction of organization, than the brain of an adult. The substance of a child's brain is soft and yielding, while the bones of the cranium are loose and yielding, and for the same purpose, to admit the compression of the head at birth.

## OF THE EXTERNAL DIVISIONS OF THE BRAIN,

## AND

## OF THE PARTS SEEN WITHIN IT ON DISSECTION.

It has been usual to disengage the brain from the skull, and to examine it in its different aspects; and looking upon it thus to divide it, first into the *cerebrum* the greater and anterior brain, and the *cerebellum* the lesser and posterior brain, and into a third part which appeared obviously the part common to both, viz. the *medulla oblongata.* The medullary masses of both cerebrum and cerebellum being visible, as it were descending in form of *crura*, they seem, and have always been described as combined in the *nodus cerebri*, to form this prolongation into the third grand division, the *medulla oblongata;* and this last portion, though much less than the other

grand divisions, has always been held important from its manner of formation or its connections.

After this first division into cerebrum, cerebellum, and medulla oblongata, anatomists have made a further subdivision of the cerebrum into hemispheres, viz. those two grand lateral divisions visible on the upper surface; and turning these hemispheres up so as to exhibit the irregularities on their lower surfaces, they have made the further divisions into *anterior*, *middle*, and *posterior lobes* of the cerebrum.

The cerebellum is described in the same manner; first we distinguish a central part, sometimes called *corpus vermiforme,* and two great lobes or hemispheres, which, indeed, constitute the longer portion of the body in the human subject; but which are, notwithstanding, parts superadded to the original and fundamental part, as seen in the lower animals.

The medulla oblongata is very obviously divided by a rapha on the fore and back part into two lateral portions.

Having noticed these divisions, we proceed to inspect the interior of the brain.

To explain the connections of the several parts of which the brain consists, there have always been two methods; the one commencing with the base of the brain, splitting and turning up the crura, and prosecuting them in this course inwards; the other by sections commencing on the upper part of the cerebrum, and dividing its substance to inspect the cavities.*

* These two methods were followed by Mr. John Bell, in his Lectures, and have always been followed by me, since I gave public lectures; and they have been followed by the old anatomists, and must be followed while the object of this study is acknowledged to be, first, to understand the connection, and, secondly, to understand the morbid anatomy of the brain.

Those who would neglect the method of dissection from above downward, are equally ignorant of the uses of the anatomy of the brain, with those who in fine enthusiasm declare their admiration at Dr. Gall's and Dr. Spurzheim's demonstration from below upwards. These gentlemen say, they are vindicated in their ignorance, since

### OF THE CAVITIES OF THE BRAIN IN GENERAL.

Before giving the demonstration of the ventricles, I must affirm, that there are no cavities in the brain, and no surfaces which can correctly be called internal. The walls of the ventricles lie in contact: there is no space betwixt them, and, therefore, in correctness of language, no cavity. But I have another meaning in saying that there are no internal surfaces. To comprehend the proper structure and relation of the parts of the brain, it is necessary to recollect that these cavities can be laid open without making a breach into the proper substance of the brain, and, therefore, that they are, in fact, the surfaces continued from the exterior convolutions of the brain, and the ventricles, therefore, are formed by the portions of the brain rolled up and adhering at certain parts by the pia-mater.

There are within the brain many tubercles and irregular surfaces, of which it is infinitely more difficult to convey an idea by description than of the external parts. The surface of the cavities or ventricles of the brain is naturally bedewed with a fluid or halitus, which flows from the general surface of the ventricle, and from the plexus choroides. This moisture preserves those surfaces from adhesion: during life and health it is not accumulated so as to form a fluid; but in many diseases, and after death, it is effused or collected into a fluid. The external convolutions of the brain we have seen to be cineri-

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the brain never was dissected before! The demonstration of the connection of the parts of which the brain consists, and the relation of the parts to the origin of the nerves, is necessary to the comprehension of the structure, and is very proper. But the dissection of the brain with the knife, opening its cavities to observe its interior structure, in their natural and undisturbed position, is the more important and ultimate object, since the whole jet of the enquiry is to enable us to detect the appearance of disease.

tions on the surfaces; the internal surface of the brain may be considered also as forming convolutions; but they are chiefly medullary, and are more irregular, or rather have a greater variety of shape, than those of the outer surface.

In regard to the use of the ventricles of the brain, since the hypotheses of the older physicians have been tacitly rejected, no opinion has been offered, except this, that "they seem to be made of a necessary consequence, and towards the greater use and distinction of parts;" or, as we have already had occasion to mention, that the ventricles serve to increase the surface of the pia mater, and that whatever may be the purposes which are served by that membrane on the surface of the brain, we must suppose the same to be performed by it within the ventricles. But this is a conclusion which may not be altogether satisfactory to an inquisitive mind.

It is necessary to take into consideration the general peculiarities of the brain: we find that within the skull there is no adipose substance, though it pervades every other part of the body. We at once see a reason for this. It is evident that as the fat is incessantly undergoing changes (being alternately absorbed and deposited); as at one time it is deposited in greater quantities, and at another absorbed; as it is in perpetual variation according to the prevailing habits of the body, the proportion of exercise taken, or the state of the health; its continual changes would have the very worst consequence upon such a part as the brain; that if accumulated, it would oppress the circulating vessels; if rapidly absorbed, it would be followed by accumulation or surcharge of the vessels; for the skull does not allow of distention, nor is it possible that the cavity of the cranium can admit of depletion.

The ventricles of the brain are in their natural state merely surfaces in contact. The forms of these internal surfaces are resulting from the internal conformation of the substance, as the great external con-

vexities are, and as the superficial convolutions are; I have just said, that we can arrive at these interior surfaces by splitting up the divisions of the brain without tearing the substance of it.

The next enquiry is, Why this evident difference of surface within and without the brain? The *cavities*, as we shall continue to call them, have no arachnoid coat, they have, therefore, secreting surfaces. Here is the real distinction of the external and internal surfaces of the brain. It has long appeared to me that these cavities and the provision for secretion into them had a very particular influence, in preserving the due relation of the parts of the brain, which would otherwise be deranged or unequally pressed. A collection of water in the ventricles of the brain is, perhaps, the most frequent of all diseased appearances, and when within the ventricles it is much less injurious than in the external surface; when collected on the surface, under the tunica arachnoidea, it is ever attended with oppression of the faculties.

It is not to be supposed that the ancients, so fertile in their hypotheses, and so easy in their proofs, could neglect the evident importance of the ventricles of the brain. We accordingly find that the spirits were manufactured in these cavities; that they were the "spirituum animalium officina," whence the spirits were conveyed over all the nervous system.* They were again degraded from this higher office, and became the mere receptacles of the excrementitious matter of the brain (meras cloacas esse asseruerint†); and Willis seems inclined still further to degrade the importance of the ventricles, by considering

* Lately, by chemical aids, (which make the cineritious substance black, or dark brown, while the medullary matter remains white or takes a slight greenish tinge,) the origin of many of the nerves have been traced into the substance of the brain even to the surface of the ventricles, which has given occasion to the revival of similar ideas of the use of the ventricles.

† Willis Cereb. Anat. p. 32.

them merely as of secondary importance; or rather as resulting solely from the accidental conformation of the brain.* Again, we find it a prevalent opinion that the ventricles contained air; that the air supported the soft medullary substance of the brain; and that it gave motion to the whole mass, so as to circulate the spirits in the substance of the brain.†

## OF THE CORPUS CALLOSUM AND CENTRUM OVALE OF VIEUSSENS.

The CORPUS CALLOSUM is a medullary body which is a centre of communication; or, it is the great commissure ‡ passing betwixt the hemispheres of the cerebrum §: it is seen without incision by merely separating those hemispheres with the fingers. It is a white body, firmer than the rest of the medullary substance. It is but slightly convex upon its upper part, but turns convex downwards upon the fore and back part. As the corpus callosum is the continuation of the internal medullary substance of the

" * Porro si quis cerebelli fabricam exacto considerat, et serio " perpendit, quod hi ventriculi non ex primaria naturæ intentione " efformentur, at secundario tantum et accidentaliter de cerebri " complicatione resultent." &c.

† Malpighi.

‡ Commissure is a term applied to those tracts generally of medullary matter, which passing through the brain are supposed to be media of communication.

§ Willis conceiving the spirits to lodge and circulate in the superficial convolutions of the brain (upon the conformation of which depended the capacity or ability), gives to the corpus callosum the property of collecting and concentrating the spirits, " quasi in " *publico emporio* commorantur;" and here they were depurated by repeated circulation. — The language in which all this is delivered, conceals the absurdities of the doctrine: " Spiritus " recens nati undequaque ab extima hujus corporis ora versus an- " teriorem istius corporis callosi partem, ubi crassimum existit, " perpetim blande scatent; ibidemque, si opus fuerit, aut imagi- " nationis actui impenduntur, aut medullæ oblongatæ crura sub- " euntes, appendicem nervosam actuant et inspirant." What remains superfluous of the spirits returns backwards and circulates through the fornix, and is still farther subtilized, " hoc motu sub- " tiliores quosdam phantasiæ actus peragunt."

brain, it is superfluous to say that it is continued down, anteriorly, into the medullary matter betwixt the corpora striata, terminating in its pedunculi; or backwards, that it is continued with the fornix and cornua ammonis and the surface of the posterior prolongation of the lateral ventricle.

We see upon the surface of the corpus callosum two medullary lines considerably raised, running parallel to each other * in the length of the body. Betwixt these salient lines there is of course a kind of rut, called sometimes the rapha, or suture, which may be considered as dividing this body into two equal parts, and which, in truth, forms the accurate division of the two sides of the whole brain.†

Other lines, less elevated from the surface, are to be observed running across these, as if passing from one hemisphere to the other. If the corpus callosum be cut horizontally, and the section be continued into the substance of the hemispheres, we still can perceive those transverse lines, and observe them to be lost in the medullary matter of the hemispheres.‡

This body is properly called the great commissure (*commissura magna*), for it is the great part of medullary matter which formed by transverse striæ incorporates and unites into one whole the two lateral divisions of the cerebrum.

* They are not strictly parallel in all their length; we find them often separated both upon the fore and back part; but generally more separated upon the back part, and even sometimes they are curved.

† In which conceit Duverney calls this "clef du cerveau," from its being the centre of communication. Tom. i. p. 39.

‡ The necessity of explaining paralysis and convulsive motions of that side of the body opposite to the side of the brain injured, have made anatomists attend to those transverse lines, in the hopes of finding such a decussation of these lines as would account for it. Sabbatier says, they have brought themselves to believe that there was a decussation, but after careful investigation he could find no such thing, See Winslow. Ludwig (de Cinerea Cerebri, sub. p. 5.) observed striæ of cineritious substance in the corpus callosum. See also Gunz, and Haller.

### CENTRUM OVALE OF VICUSSENS.

The CENTRUM OVALE is merely the appearance which the white and internal part of the cerebrum takes when the brain is cut horizontally on the level of the corpus callosum; for then the corpus callosum is the centre of the great medullary mass of the cerebrum, and the cineritious matter being on the external edges only, forms the central white mass into an irregular oval.

### THE SEPTUM LUCIDUM.

The two lateral ventricles lie under the corpus callosum and medullary centre; they are divided by a partition, which descends from the lower surface of the corpus callosum, and rests upon the fornix. This septum of the ventricles is transparent, and consists of two laminæ, and each of these consists of medullary and cineritious matter.* Betwixt these laminæ is the cavity of the septum lucidum.† The size and shape of this cavity differs in a variety of subjects. It is of a triangular shape, and from eighteen to twenty lines in length.‡ It has a fluid exhaling into it like the ventricles, and is by some counted as a fifth ventricle: according to Santorini it opens in the base of the brain, opposite to the union of the optic nerves. Vieussens describes it communicating with the third ventricle.§ Winslow also has seen it reaching a great way backwards, and conceives it to open into the third ventricle. Soemmerring describes it as large in the middle, contracted backwards, and having no communication; but he asserts that it is shut in on every side.|| In the base of the brain we find a narrow longitudinal sulcus

* Vicq d'Azyr.

† It was discovered by Silvius. See also Santorini.

‡ Sabbatier.

§ "In qua pellucidam non raro reperimus aquamque haud "dubie in tertium illabitam ventriculum." Vieussens de Cerebro, p. 59.

|| De Corporis Humani Fabrica, tom. iv. p. 55.

betwixt the pedunculi of the corpus callosum. In the bottom of this cavity there is a medullary lamina, which Vicq d'Azyr calls "*Cloison à la cavite du septum lucidum.*" And the sulcus he calls "*Fosse de la base, du* SEPTUM LUCIDUM." By a careful section of this medullary substance, we lay open the cavity of the septum lucidum.

### LATERAL VENTRICLES.

Under the corpus callosum and medullary centre, and on each side of the septum just described, are the lateral ventricles. They are distinguished into right and left. They are of a very irregular shape, stretching into three prolongations or cornua, whence they have the name of tricornes. They are the great ventricles of the brain; the third and fourth being comparatively very small. What may be considered as the principal chambers of these ventricles are formed betwixt the corpus callosum, the medullary substance forming the centrum ovale, and the convexity of the corpora striata and thalami nervorum opticorum. Following the cavity forwards, we find what is called its ANTERIOR HORN or sinus; it is formed betwixt the more acute convexity of the corpus striatum and the anterior part of the corpus callosum: the posterior horn stretches into the posterior lobe of the cerebrum, which rests upon the tentorium. It makes a curve outwards, and at the same time inclines a little downward.

The INFERIOR OR DESCENDING HORN is like the continued cavity of the ventricle: it takes a curve backwards and outwards, and then turning forwards and downwards, it descends into the middle lobe of the brain.

The lateral ventricles do not terminate in the others by any of those prolongations; but they communicate, upon a very high level, with the third ventricle and with each other, by a wide opening, formed under the fore part of the arch of the fornix. This communication we easily find by following the

choroid plexus forward and under the fornix: it is a space betwixt the most anterior part of the convexity of the optic thalami and the anterior crura of the fornix.

### OF THE PARTS SEEN IN THE LATERAL VENTRICLES.

The FORNIX is a medullary body, flat, and of a triangular shape: its lower surface is towards the third ventricle: its lateral margins are in the lateral ventricle. On its upper surface it supports the septum lucidum, or partition of the two lateral ventricles, and under its most anterior part is the communication betwixt the lateral ventricles and the third ventricle. * One of the angles is forward, and the other two towards the back part: it rests chiefly upon the thalami nervorum opticorum, but it is separated from them by a vascular membrane, which is continued from the external pia mater, and which stretches into the brain betwixt the posterior part of the corpus callosum and tubercula quadrigemina. This membrane connects the plexus of the lateral ventricle. The fornix leaves betwixt it and the convex faces of the anterior parts of the corpora striata, a triangular space, which is in part occupied by the septum lucidum.

The extremities of this body are called crura. The posterior crura coalescing with the corpus callosum, (which is continued downwards posteriorly,) are prolonged upon the edges of the hippocampi, and the anterior crura, forming the anterior angle, being close together, bend downwards before the anterior commissure, and are connected with it: they then bend round the thalami, and may be traced into the crura cerebri; or, according to others, they form the corpora albicantia. † Those pillars or crura of the fornix are fibrous in some slight degree like a nerve. This

* Of this communication see farther in the Anatomy of the Brain, illustrated by engravings.

† Two white bodies seen on the base of the brain behind the infundibulum.

is to be observed by cutting them either across or in their length.*

Upon the lower surface of the fornix there are lines like those of the corpus callosum, and which are erroneously conceived by many to be the impression of the vessels of the velum. It is this lower surface of the fornix which is called LYRA, CORPUS PSALLOIDES, it being compared to a stringed instrument.†

### OF THE HIPPOCAMPI, OR CORNUA AMMONIS, AND OF THE TENIA HIPPOCAMPI.

These are parts to be seen by following the posterior crura of the fornix. They are covered by a soft vascular substance, the plexus choroides. We have observed, that upon the back part, the fornix adheres to, or is continuous with, the corpus callosum. We shall find also that its posterior crus on each side divides into two lamina of medullary matter: the one of these is continued into the cornu ammonis, and the other (being the anterior of these portions) forms the tenia hippocampi.

The hippocampus is narrow at its commencement in the posterior crus of the fornix ‡; but is enlarged as it descends, following the course of the inferior

* Vicq d'Azyr, Acad. Scien. 1781, p. 517.

† The prevalent idea amongst the older authors regarding the use of the fornix was, that it acted like a ligament binding together the internal parts of the brain; or that it supported the incumbent weight of the upper parts of the brain from pressing upon the lower. "Verum alter atque iste insignior fornicis usus "esse videtur quem modo inuimus; nempe ut spiritus animales "per ejus ductum ab altera cerebri extremitate ad alteram imme- "diate transeant, atque ita quasi per pelicani rostrum in sui "ipsius ventrem intortum circulentur." Willis.

‡ In speaking of the origin of the hippocampus as from the fornix, I mean simply that the student having gained the knowledge of one part of the brain may trace the others from their relation to it, and that, understanding the situation and relation of the fornix, he traces its crura until he finds them terminating in the hippocampus. We might fully as well say that the hippocampi are formed from the posterior part of the corpus callosum, for they are the same medullary matter continued.

prolongation of the lateral ventricle towards the base of the brain. It is, indeed, merely a relief or particular convexity of the floor of this lower horn of the ventricle, like a pad. The inferior extremities of the hippocampi on each side turn inwards, pointing to the crura cerebri, and taking thus a curve like a ram's horn.* In its whole extent the hippocampus consists of an internal cineritious substance, and a superficial layer of white medullary matter.†

The TENIA HIPPOCAMPI, OR CORPUS FIMBRIATUM, is the prolonged margin of the fornix: it is merely the thin edge of the hippocampus, which follows in the whole of its circuit, and terminates in an acute point near its bulbous extremity in the inferior horn of the lateral ventricle.

The LESSER HIPPOCAMPUS OR COLLICULUS, is a relief or convexity in the floor of the posterior horn of the ventricles, which may be traced backwards from the crura of the fornix. It has the same relation to the fornix which the greater hippocampus has, and lies in the posterior horn or prolongation of the ventricle into the posterior lobe of the brain, in the same way in which the great hippocampus lies in the inferior horn or prolongation of the ventricle into the middle lobe of the brain.

The VELUM and PLEXUS require to be taken away before we can fully understand the situation of the third ventricle, or of those tubercles which are but partially seen in the lateral ventricles.

The VELUM VASCULOSUM lies in the centre of the

* Betwixt the extreme point of the hippocampi and the crura cerebri (when the base of the brain is turned up) we can insinuate the probe into the inferior horn of the lateral ventricle, without piercing the substance of the brain, but merely tearing the pia mater.

† "Vers la partie inférieure et postérieure du corps calleux, "on trouve, de chaque côté, un petit bourrelet de substance grise "qui se prolonge dans l'épaisseur de l'hypocampe, dont il fait "partie: ce bourrelet est recuvert dans son principe par une lame "de substance blanche." Vicq d'Azyr, loc. cit.

brain, and extends from the surface inward betwixt the posterior lobes of the cerebrum and the cerebellum, then betwixt the corpus callosum and nates and testes, and then under the fornix. It forms thus a great communication betwixt the external and internal membranes of the brain. As it lies under the fornix, that medullary lamina adheres to it, while the velum again adheres to the thalami nervorum opticorum, which are beneath it. Its margin seems to be terminated laterally by the choroid plexus (when we view it after raising the fornix); but it is not strictly so, for the choroid plexus is continued with the membrane of the ventricles, and has no where a termination. For the vascularity of this membrane, turn to what has already been said in speaking of the internal veins of the brain.

Seeing how the plexus choroides are formed and connected, they cannot be strictly said to have either beginning or termination; they are the connected folds and plicæ of the internal membrane of the ventricles loaded with vessels; but to describe them intelligibly we must, notwithstanding, trace them in this manner. The PLEXUS of the LATERAL VENTRICLES rise from the bottom of the inferior horns of these ventricles (called the digital cavity), betwixt the pedunculi or crura cerebri and the termination of the hippocampi; they lie like fleshy bodies in that lower horn. As they rise into the superior level, they are at their greatest size (there they have often a diseased appearance, being hard, and as if schirrous or full of little vesicles or hydatids); they then pass forwards and inwards, diminishing in thickness, and approaching gradually until they coalesce under the fornix, and immediately behind the communication betwixt the ventricles. The PLEXUS OF THE THIRD ventricle, formed by the union of those of the lateral ventricles, turns back upon the lower surface of the velum, and is comparatively very small. If my reader has any difficulty in comprehending the relation and place of the *velum interpositum*, he has

only to notice the place of the choroid plexus, lying the one in the left and the other in the right lateral ventricle; then he is to lift the fornix and he will discover a vascular membrane passing betwixt the plexus of the right and left sides. This is the *velum* or *diaphragma*.

The CORPORA STRIATA are smooth, cineritious convexities in the fore part of the lateral ventricle. They are somewhat of the shape of a pear; they are obtuse forwards; they approach each other towards the fore part with a regular convexity, and they are narrow as they pass backwards, separating at the same time; their posterior extremity being as it were pushed out by the thalami nervorum opticorum. These last lie more under the back part of the fornix, and are more concealed when the lateral ventricle only is laid open. The corpora striata are so called from the intermixture of the medullary matter in their substance, which gives the appearance of striæ when they are cut. They descend down to the base, and are intimately connected with the crura cerebri. The striæ of medullary matter pass from above downwards, they therefore appear in the horizontal sections of this body like white points. A superficial horizontal section of the corpora striata shows those striæ connected with the medullary matter of the middle and posterior lobe. A deeper incision brings into view a mass of cineritious substance betwixt those striæ and the medullary matter of the middle lobe. Another incision shows the course of the striæ altered, and brings into view the connection betwixt the corpora striata of each side, by means of the anterior commissure.*

* *Hæc pars commune sensorium est,* quod sensibilium omnium "ictus a nervis cujusque organi dilatos accipit adeoque *omnis* "*sensionis perceptionem afficit;* cujusmodi sensibilium ictus, cum "hinc ulterius in cerebrum trajiciuntur, *sensioni* statim imaginatio "succedit; atque insuper hæc corpora, uti sensuum omnium im-"petus ita motuum localium spontaneorum primos instinctus "suscipiunt." Willis, edit. 4. p. 43.

The COMMISSURA ANTERIOR is a cylindrical medullary cord, which unites the fore and lower part of the corpora striata, and which spreads its connections for a full inch and a half into the middle lobe of the brain upon each side. We see it stretched transversely immediately under the anterior crura of the fornix. It is in figure like a bow; its extremities stretching (with a convexity forward) into the middle portion of the brain towards the extremity of the fossa Silvii, where it terminates in the medullary matter of the middle lobe of the brain.

The THALAMI NERVORUM OPTICORUM are hid by the posterior angles of the fornix, and the plexus choroides: we do not see them fully until we have lifted the fornix, and the velum or membrane which stretches under the fornix. They are somewhat of an irregular oval shape; they are whiter than the corpora striata, their surface being chiefly of medullary matter. Internally they are cineritious; and the medullary and cineritious matter is blended in striæ like the anterior tubercles of the ventricles or corpora striata.

The thalami nervorum opticorum, having their convex surface towards each other, unite under the fornix by what is called the COMMISSURA MOLLIS, in opposition to the commissura magna, which is the corpus callosum; the commissura anterior, which unites the fore part of the corpora striata; and the commissura posterior, which is yet to be described.

This soft commissure of the brain, or the union of the optic thalami, is so soft that the slightest force will tear it, or in dissection, the parts being unequally supported, the thalami will be separated and this connection lost.* After such separation of the tubercles, there remains very little appearance of their having been united. Sabbatier, after the most careful dissection, says expressly that he could never ob-

* Morgagni and Vicq d'Azyr say they have seen this commissure double.

serve this union; and he conceives, that in the smoothness of the contiguous surfaces he has a proof of there never being such a union; but he goes on to say, "The fruits of my research were, that I constantly "found a soft cord of a cineritious colour, and about "a line, or a line and a half in diameter passing be-"twixt them.

I have seen, when the ventricles were distended in hydrocephalus, and the communication betwixt the three ventricles enlarged to a square cavity of nearly an inch in diameter*, that this union was drawn out to some length, but still was above half an inch in diameter. The commissura mollis is exceedingly soft, of a cineritious colour, and vessels are sometimes seen to cross upon its surface. It seems to be the continuation of the grey or cineritious substance which covers the internal surface of the optic thalami.†

Towards the fore part of the thalami we have to observe a peculiar eminence or convexity, viz. the ANTERIOR TUBERCLES of the optic thalami. In making a horizontal section of the thalami, we find that we cut across a medullary streak or cord which descends from this tubercle to the mamillary processes, or corpora albicantia, in the base of the brain.‡ Its course is deep in the substance of the brain, and somewhat oblique. The limits of the thalami externally are contiguous to the corpus striatum, but betwixt them there intervenes a white medullary tract, which is continuous with the medullary striæ, and which, as it marks the limits of the two great tubercles of the lateral ventricles, takes a course inwards towards the anterior pillars or crura of the fornix and middle of the anterior commissure. The surface

* In quadrupeds the adhesion is more extensive.

† Mais il n'y a point de continuité, proprement dite, entre la substance intime de ces couches et la commissure molle dont il s'agit. Vicq d'Azyr, Planc. de Cerv. p. 23.

‡ See Vicq d'Azyr, plate xii. Mém. de l'Acad. Royale, 1781, p. 528. and plate 2. fig. 5.

of this tract, as seen in the lateral ventricle, is the TENIA SEMICIRCULARIS GEMINUM, which we shall presently more particularly describe.

To understand the further connections and importance of the optic thalami, we must dissect the base of the brain. There we find that it is through the corpora striata, and the thalami nervorum opticorum, that the crura cerebri establish their extensive connection with the internal mass of the brain ; particularly we find that the crura shoot up into the back and lower part of the thalami.

Here on the lower part also we may observe the TRACTUS OPTICUS, which we may trace backwards from the optic nerves. They surround the crura cerebri with a semicircular sweep, swelling out at the same time, and terminating in three considerable tuberosities : they are finally confounded with the lower part of the optic thalami * ; at the same time there runs up a division into the nates.

The TENIA SEMICIRCULARIS GEMINUM is visible on the upper part of these convexities in prosecuting the dissection from above ; it is the tract of the medullary matter, which is betwixt the two great tubercles of the lateral ventricle, the corpus striatum and thalamus nervi optici. Towards the fore part of this tract its surface is covered with a layer of a semitransparent greyish matter, through which we see the veins which pass from the surface of the corpora striata to join the vena Galeni. † Sabbatier makes

* Willis seeing the first and second pair of nerves so closely connected with these tubercles, and supposing, as we have mentioned in a former note, that the corpora striata were the common sensorium, concludes, "hinc ratio patet, cur odores sine olfactus objecta ipsum adeo cerebrum feriunt, et immediatè afficiunt : item cur intervisionem et imaginationem communicatio citissima habetur." P. 44.

† "Quelquefois il se detache du tænia semicircularis entre le corps strié et la couche optique un silet blanc, que faissant un angle très aigu, soit en devant soit en arrière, monte à une certaine hauteur sur le corps cannele." Vicq d'Azyr, Mém. de l'Acad. Royale, 1781, p. 530.

the anterior extremity of this medullary body join the anterior pillar of the fornix. Haller makes it join the anterior commissure; and Vicq d'Azyr says they separate again, where they seem to unite forwards and lose themselves on the corpora striata. Their posterior extremities are lost in the hippocampi; they thus form a kind of longitudinal commissure which establishes a communication betwixt the fore and back part of the cerebrum.

### OF THE THIRD VENTRICLE.

The third ventricle does not at all answer to the conception we form of the ventricles from the lateral ones. It is a mere sulcus, lying betwixt the thalami nervorum opticorum, and betwixt the crura cerebri, which are continued down from these tubercles. It is a longitudinal slit, rima, or gutter-like cavity, which is made irregular, and is divided by the union of the optic thalami: and finally, it is canopied by the fornix and vascular velum which stretches over the thalami.*

The third ventricle opens forward and upwards into the two lateral ventricles, and under the common communication it opens into the infundibulum. Backwards it is continued by a canal which passes under the tubercula quadrigemina, or nates and testes, into the fourth ventricle. The bottom of the third ventricle is closed by a small stratum of cineritious matter, *cloison pulpeuse du troisieme ventricule;* this fills up the space betwixt the junction of the optic nerves and the anterior commissure. We see it when dissecting the base of the brain. Lifting the optic nerves, we shall find it strengthened by the pia mater, and consisting of striæ which pass obliquely backwards and downwards, and some of which, while they adhere to the optic nerves, pass into them.

* "Hanc caveam ventriculum tertium vulgo vocant, quæ et "ipsa cum plena sint omnia nihil est nisi contiguorum thalamorum "limes." Haller.

As we have found that the pia mater could be traced into the lateral ventricles, and as by tearing with the probe the connections of those membranes, we could penetrate into the lateral ventricle without piercing the substance of the brain ; so here we can penetrate into the third ventricle, which is deepest of all ; and also into the fourth, without lacerating the substance of the brain. Thus after raising the vascular membrane of the base, we can pass a probe under the corpus callosum backwards into the third ventricle, and by raising the cerebellum from the medulla oblongata, and separating the adhesions of the pia mater, we get access to the fourth ventricle. We conclude, then, that the ventricles are not formed, as we should at first conceive, in the substance of the brain, but that they are formed by the replication and foldings of the convolutions of the brain.

## OF THE INFUNDIBULUM.

As I have explained in my tables of the brain, there is much confusion regarding the terms vulva and anus. Vulva is the space by which the three ventricles communicate, as seen when the fornix is lifted, in prosecuting the dissection from above downwards, viz. betwixt the thalami nervorum opticorum and before the commissura mollis. The anus is behind this commissure, and near the nates and testes ; both these are mentioned as communications betwixt the ventricles ; but we know that the union of the plexus choroides, of the two lateral ventricles, and of the termination of the velum under the anterior part of the fornix, leaves the vulva free. But the velum spreading over the thalami, and under the posterior part of the fornix, covers the anus ; and it appears as a communication similar to the other only when the velum is torn up.

If we pass a probe gently downwards and forwards from the vulva or foramen commune anterius, or communication betwixt the ventricles, we pass it into the infundibulum. The INFUNDIBULUM is a funnel of

a soft cineritious matter, which leads from the bottom and fore part of the third ventricle towards the glandula pituitaria, which is seated in the sella turcica of the sphenoid bone.

The infundibulum is formed of cineritious matter, which is continued from the bottom of the third ventricle, and which adheres to the back part of the optic nerves; or, according to Wharton, of an external membrane with cineritious matter internally. Its cavity becomes contracted before it reaches the glandula pituitaria. Whether it be really capable of conveying the fluids of the ventricles, or whether it be actually pervious, is likely to remain a disputed point. Tarin, and M. Adolphus Murray, and Haller, believe with the oldest writers that it is pervious. Soemmerring and Vicq d'Azyr have in their experiments found it shut.* But to the opinion that the infundibulum conveyed the superfluous moisture from the ventricles †, it did not seem necessary to Vieussens that we should find it to have a cavity in all its length. He conceived that where the apparent cavity terminated, less visible pores were continued towards the gland.

* "Sed non ad apicem usque pervium." Soemmerring.

† "Structura, situque infundibuli spectatis, connectionis, et "societatis, quam cum cerebro, et glandula pituitaria habet, ra-"tionibus æquo judicio perpensis, unicum illius usum esse, ut "aquosum, seu lymphaticum quemdam cerebro depluentem hu-"morem, majoris, ad instar vasis lymphatici excipiat et pituitariam "versus glandulam sensim transmittat, non autumare non possu-"mus: Etenim eum intertextarum plexibus choroidæis glandu-"larum usus sit, ut sanguinis calvariam subeuntis, spiritusque ani-"malis materiam suppeditantis, aquosiorem partem, desinentibus "in ipsas ab arteriis depositum excipiant, quæ deinceps per insen-"siles rarissimæ, qua obducuntur, membranæ poros, sensim trans-"fluit, et partim per vulvam partimve per anum, in tertium cere-"bri ventriculum delabitur; nullus esse videtur ambigendi locus, "quin aquosus omnis humore glandulis, quæ plexuum choroidæ-"orum vasis interseruntur, sensim affluens, ad infundibulum de-"feratur." Vieussens, p. 50. Such was the opinion regarding the economy of the brain, and now we have no theory, good or bad, nor any explanation of this cônnection of the gland with the ventricles of the brain to offer.

## INFUNDIBULUM AND PITUITARY GLAND.

What is called the PITUITARY GLAND is a reddish body of a glandular-like structure *, which is seated in the sella Turcica of the sphenoid bone. It is plain upon its upper surface, or rather perhaps a little hollowed, of a globular shape below, and having a division into two lobes. The infundibulum terminates in it, piercing the dura mater, a thin lamina of which spreads over the gland. The gland lies surrounded with the circular sinus, and has the cavernous sinus upon the sides; into these last, vessels have been seen to pass from the gland †, which, as Soemmerring observes, were probably veins. A distinction of substance has been observed in this gland, and it is by some considered as a part of the brain, or being like the cineritious substance, it has been supposed that it gave nerves to the fifth or sixth pair.

It was conceived that this body receiving the superfluous moisture of the brain, conveyed it into the nose; or into the neighbouring sinuses.‡ To countenance this opinion, there was no want of cases proving the accumulation of the fluids of the ventricles, in consequence of the schirrus of this gland §, while in truth dissection has shown no connection betwixt the diseases of the ventricles and pituitary gland. M. Littre gave both a vascular structure and muscular fibres to this body, and conceived that its oper-

* It perhaps has only the form of a gland. Haller, says, "non "acinosa quidem, neque nullius alterius glandulæ similes, quæ po-"tius cerebri quidam sit appendix." See also Bordeu, Recherch. Anatomiq. sur les Glands. Pituet Glandulæ Vitium, Sandift. Thes. Vol. III.

† Adolph. Murray de Infundib.

* Lower, Tract de Corde.

§ Schneider (de Catar.) first opposed this theory; showed that there was no communication betwixt the brain and the nose, and maintained that no fluid, not even the blood which flowed from the nose, had any connection with the brain: he was supported by other able anatomists. The old opinion was revived by M. *Bouillet, Elemens de Medecine pratique.*

ations brought down the water and air from the ventricles of the brain.*

### THE TUBERCULA QUADRIGEMINA.

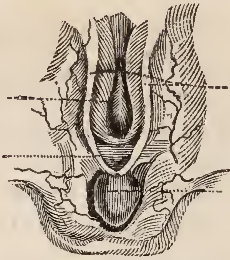
The tubercula quadrigemina, or nates and testes, are seen when we continue to lift back the posterior part of the fornix and corpus callosum, and when we have lifted back the velum with the vena Galeni. We find, in doing this, that the velum is connected with the pineal gland, which is seated upon these tubercules.

The tubercula quadrigemina are not in the cavities or ventricles of the brain, but are seen upon lifting and turning forward the posterior lobes of the cerebrum from the cerebellum.

These four tubercules are behind the third ventricle, and above the fourth. As they are immediately in the centre of the brain, they form a kind of commissure, and they both communicate with the tubercles, from which the tractus opticus emerges. The uppermost two are the NATES, the lower are the TESTES; the former are less white than the latter. A little under the inferior tubercle we find a small tract of medullary matter which extends to the thalami nervorum opticorum, and the crura cerebri. And from the lower part of the testes there projects backwards, connecting itself with the crura cerebelli, a thin medullary lamina, which is the VALVULA VIEUSSENII, PROCESSUS A CEREBELLO AD TESTES, or VELUM INTERJECTUM. Behind the posterior tubercle, or from this medullary lamina itself, the fourth pair of nerves take their origin. Sometimes those four tubercles are of the same size; sometimes the posterior, sometimes the anterior tubercles, are the larger: a perpendicular section of them shows a mutual communication of striæ of medullary and cineritious matter, but those are seen faintly.

* See Littre, Mem. de l'Acad. des Sciences, 1707.

## THE PINEAL GLAND.




The pineal gland is a little glandular-like body, seated above the tubercula quadrigemina, and behind the thalami nervorum opticorum; it is fixed, says Winslow, like a button. It consists of cineritious matter covered with the pia mater; its base is surrounded with medullary matter; it adheres firmly to the velum vasculosum, and is apt to be displaced or torn from its pedunculi in lifting that membrane. It is a small soft greyish body, irregularly round, or of the figure of a pine-apple; or, of all things, likest the heart of a frog.* Its pedunculi, or footstalks, pass out from a transverse medullary base, which unites it to the posterior commissure. Those pedunculi pass on each side to the thalami nervorum opticorum (leaving a passage under and betwixt them to the fourth ventricle). Their extremities pass forward upon the internal surface of the thalami nervorum opticorum, and are united to the anterior crura of the fornix.

Vicq d'Azyr remarks, that although the ideas of Galen and Descartes †, and a crowd of others, are

* Ruysch considered the substance of this gland as different from that of the cerebrum or cerebellum, and different, also, from all other glands.

† Alluding to their opinion of this being the seat of the soul; Willis imposed upon this part a lower office, "Ejusque munus "non aliud omnino esse quam aliarum glandularum quæ juxta va- "sorum sanguiferorum concursus disponuntur; nempe ut humores "serosos a sanguine arterioso depositos, excipiat, et in se reti-

remembered only with ridicule, there are still some peculiarities in the situations and connection of this body, which mark its importance. It is composed of cineritious substance; it is in fact, a prolongation of the substance of the brain, and by its pedunculi, which are like two nerves, it is connected with the thalami nervorum opticorum, with the fornix and consequently with the corpus callosum, the hypocampus and corpora albicantia, which are themselves the centre of union to several medullary cords: therefore he concludes that the pineal gland must be an important organ.*

The pineal gland has often in it little peculiar grains and calculi, resembling bone in its constituent parts.† It has a great variety of form and size; sometimes hollow, and there is also a sinus found in it. I have found it surrounded with pus in an idiot boy, who was accustomed to wander about the Leith glass-houses. He died with symptoms of hydrocephalus, and in his ventricles, accordingly, there was found much fluid. Malacarne gives a case of its having degenerated into hydatids, like a cluster of grapes; I have also seen this appearance. In some cases it has not been found upon dissection.

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"neat; donec aut *venæ* depletiores factæ eosdem resorbeant, aut "lymphæ ductus (si qui adfuerint) eos extra convehant." Willis, p. 46.

* Mém. de l'Acad. Royal, An 1781, p. 533. See Observ. par M. Meckel sur le Gland pineal, sur la cloison transparente, et sur l'origine du nerf de la septieme paire. L'Acad. Berlin, 1765.

† "La parte anteriore della base n'è ordinari amente midollare, "e qui appunto l'ho moltissime volte veduta gessata, ossosa, tar- "tarosa e friabile, vizi, che ho trovati anche molte volte nei pic- "cinoli." Malacarne, part ii. p. 81. *Acervulus:* Meckel, Mém. de l'Acad. des Sciences a Berlin, 1755, fig. 1. b. b. Vicq d'Azyr, tab. xxvii. "Super medullosum conarii vinculum vel in ipso vin- "culo, vel in ipso denique acervulo, plerumque vero ante acer- "vulum iam in fetibus inmaturis peculiares quidam lapilli, mox "maiorum acervulum, mox vero duo vel tres minores acervulos "constituentes, helui, semiperlucidi, iunioribus semper pallidiores, "annosioribus fusciores, infantibus ob coloris languorem et per- "lucidatem difficiles cognitu siccati albidiores et opaciores inve- "niuntur." Soemmerring, p. 63.

### POSTERIOR COMMISSURE.

The base of the pineal gland is connected with the posterior commissure of the brain. This commissure is seen like a cord, or like the anterior commissure, towards the back part of the third ventricle, before the tubercula quadrigemina, and above the iter ad quartum ventriculum. Betwixt this commissure and the base of the pineal gland, we have to observe two or three medullary filaments, not passing from the gland, but lying parallel to the commissure. But this part of the brain, which appears like a cord, does not deserve the name of commissure; it does not pass on each side into the substance of the brain, as the anterior one does; it is lost in the neighbouring border of the medullary matter, and is merely this matter reflected, so as to present a rounded edge.

### CEREBELLUM.

The cerebellum is one of the grand divisions of the brain. It weighs about a sixth or seventh part of the whole brain; it lodges in that part of the base of the cranium which belongs to the occipital bone, and has the tentorium stretched over it; it is divided into a CENTRAL OF MIDDLE PART, and two great LATERAL PORTIONS OF LOBES.

The central, or middle part, is anterior to the lobes, and betwixt them and the cerebrum: this is the part very commonly called, from its appearance, the VERMIFORM PROCESS; and upon the sides we have two portions, sometimes called lateral vermiform processes. The term process here, is certainly improper; for it implies that those parts are extended from the lobes; whereas the PROCESSUS VERMIFORMIS is the part we see in all creatures which have a spinal marrow; while the lateral lobes or hemispheres are the superadded parts, and bestowed upon the higher animals.

The cineritious matter of the cerebellum is external, like that of the great mass *of* the cerebrum; but the medullary internal matter presents an appearance somewhat different, for on a section being made, it

appears branching like a tree, and has been called *arbor vitæ*.

The concentration of the medullary matter, from the two sides of the cerebellum, towards the nodus cerebri, forms what are called the crura cerebelli. One portion of this medullary matter forms the pons or nodus, and constitutes the commissure uniting the lateral divisions of the cerebellum; the other division of the *crus* is the *corpus restiforme*, which runs into the medulla oblongata.

In dividing these crura we find in each of them the stain of yellowish matter, which is called CORPUS RHOMBOIDEUM, or CORPUS DENTATUM.

### OF THE FOURTH VENTRICLE.

The fourth ventricle is the ventricle of the cerebellum; it descends perpendicularly before the cerebellum; it is inclosed on the upper part by the valvula Vieussenii; on the sides by the crura cerebelli; behind, by the pars media; below, by the medulla spinalis, and is closed there by the pia mater.

When, from the third ventricle, we pass our probe obliquely backwards and downwards under the posterior commissure, it passes into the ITER AD QUARTUM VENTRICULUM, or AQUEDUCT of SILVIUS. This passage to the fourth ventricle, goes before the tubercula quadrigemina. The VALVULA VIEUSSENII, it was supposed, prevented the falling down of the moisture of the other cavities into the fourth ventricle *: it is more properly called the PROCESSUS CEREBELLI AD TESTES, being a medullary lamina spread over the ventricle and betwixt the crura cerebelli, as they rise from the internal medullary part of the cerebellum.

From the aqueduct there is continued down upon the fore part of the fourth ventricle a kind of fissure, which Vesalius, conceiving it to have some resemblance to a writing quill, called CALAMUS SCRIPTORIUS. The same fissure or furrow is continued down some way upon the spinal marrow.

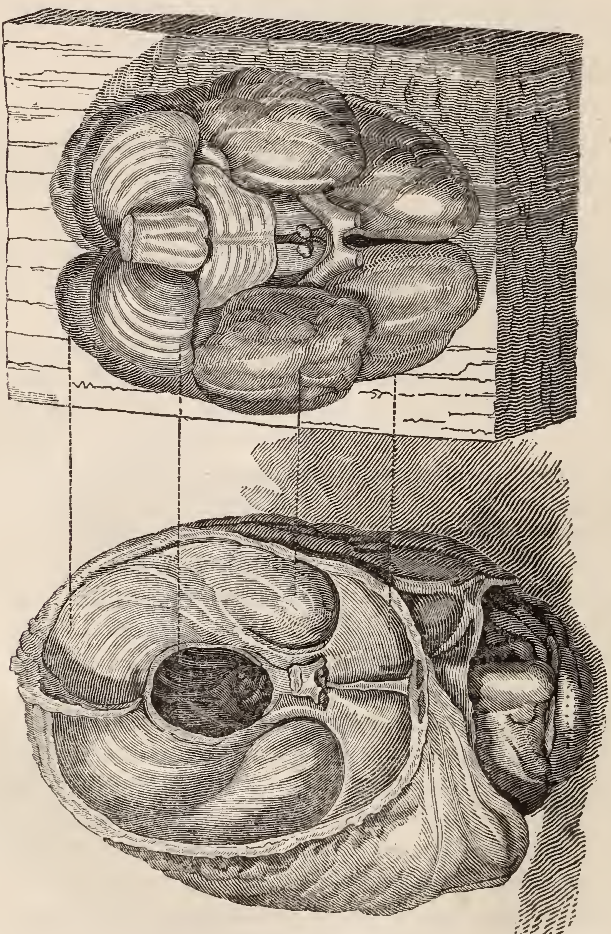
There pass up obliquely outwards, on each side

* Alveus Silvii.

of the calamus scriptorius, medullary lines, three or four in number, but sometimes seven are observed. *

In the fourth ventricle, as in the others, are some convolutions of the plexus choroides; these are on each side at the termination of the vermis; they are continued out upon the base of the brain, and are seen exposed betwixt the seventh and eighth pair of nerves.

## OF THE BASE OF THE BRAIN AND ORIGIN OF THE NERVES.



* Haller, Physiol. tôm. iv. p. 78.

We have anticipated much that might have fallen to be treated of in this division of our subject; but my intention here is to give a connected view of the parts, as seen when we have raised the brain from the skull, and when, having the base presented to us, we are about to enumerate the origins of the nerves.

The first appearance which strikes us, is the great proportion of the medullary matter in the base of the brain; the whole surface of the brain seen from above, was cineritious, but below, the centrical medullary part of the brain is seen emerging from the covering of the cineritious matter, and, gathering together from the several internal medullary processes of the brain. Those great medullary prolongations of the cerebrum and cerebellum are the crura, and from them the principal nerves arise.

Shall we here yield to the fascination of new doctrines, and derange the demonstration according to the method of Dr. Spurzheim? For the whole question amounts to this: shall we describe these crura of the cerebellum coming down from the brain, or going up and expanding into it? It is obvious, I think, that these are only modes of speaking; for we have no authority in nature for following the nerves, and processes of nervous matter, in one direction, more than another. If, therefore, I continue to say, that the crus cerebri "comes down," I mean only that from the internal parts of the brain, which, from previous description, my reader may be supposed to know is connected or continuous with the part I am now describing.

The CRURA CEREBRI are composed of a white fibrous medullary matter, in which also there is a mixture of cineritious substance. They are formed from the whole central medullary part of the cerebrum; or more immediately from the inferior and lateral part of the corpora striata, and from the superior and internal part of the thalami nervorum opticorum; and from the conflux of medullary matter,

from the anterior and posterior lobes of the cerebrum. They are, in short, formed by the converging striæ of the cerebrum. From all these various parts, the medullary matter may be traced downwards and backwards, and concentrating into a smaller space, to form the crura. The crura, contracting their diameters, unite together at an acute angle, and are united to the pons Varolii, or nodus cerebri, they pass on, under the pons Varolii, to form the anterior columns of the medulla oblongata, and, as they unite with it, they raise it into the eminences, called CORPORA PYRAMIDALIA. In those processes of the cerebrum, the cineritious and medullary substances mingle with some degree of confusion; so that when we make a section of the crura cerebri near to their union with the pons Varolii, we observe a substance of a dark-brown colour. The *locus niger crurum cerebri* of Vicq d'Azyr.

Behind the union of the optic nerves, and nearer these crura, we perceive two white bodies, called the CORPORA ALBICANTIA. Anterior to these is the *infundibulum.*— The *tuber cinerius.* In the angle of the union of the crura cerebri, behind the corpora albicantia, and before the protuberance of the pons Varolii, we observe a matter less perfectly white than the surrounding medullary substance, which forms a floor to the third ventricle. This part is perforated with a great many holes, for the transmission of blood-vessels, and is the *substance perforée* of Vicq d'Azyr. *

### CRURA CEREBELLI.

The crura cerebelli are more exposed than those of the cerebrum. A medullary mass is seen to come out of the lateral portion of the cerebellum, and join

* Vicq d'Azyr makes three divisions of this *substance perforée*— 1st. At the roots of the tubercles, from whence the first pair of nerves emerge betwixt the roots of those nerves, and near the origin of the optic nerves. 2d. Those I mention betwixt the crura cerebri. 3d. On the outer contour of the optic thalami.

itself to the posterior part of the medulla oblongata. This has been called CORPUS RESTIFORME, or PROCESSUS CEREBELLI AD MEDULLAM OBLONGATAM. That is, they have described this portion like a cord of connection, or like a prolongation of the cerebellum, to which, as a mode of expression, I say again, there is as little rational objection as to the mode of Spurzheim. It is, I believe, quite impossible to avoid the language of metaphor here. If I use the words divide or split, I am tracing, as it were, in a course for which, I again acknowledge, I have no authority in the thing itself. These crura, then, are formed by the union of the internal medullary part of the cerebellum, or the arbor vitæ, and also by a medullary prolongation from the PROCESSUS VERMIFORMIS. They are composed of medullary matter, except near the pons Varolii, where we observe a mixture of coloured striæ: and on dividing one of the crura longitudinally, as it comes out of the cerebellum, we find a mass of cineritious coloured matter. This is the CORPUS DENTATUM, or RHOMBOIDEUM of authors. *

### PONS VAROLII.

The PONS VAROLII, TUBER ANNULARE, or NODUS CEREBRI, is formed by the union of the crura cerebri and cerebelli; those names are almost descriptive of its shape and relation to the other parts. Varolius, looking upon those parts inverted, compares the crura cerebri to a river passing under a bridge, and thence named it Pons. The nodus cerebri, again is a name well applied, since this medullary eminence has much the appearance of a knot cast upon the medullary processes of the cerebrum.

On the surface of this medullary protuberance there are many transverse fibres, which, uniting in the middle, form a kind of raphe, which, upon a superficial section, shows a longitudinal medullary line. The fibres upon the surface of this body are

* Sive serratum of Vieussens: Le corps festonné ou dentelé of Vicq d'Azyr.

uniform and parallel to each other in the most projecting part; but upon the sides, they disperse to give place to the fifth pair of nerves. *

A deep incision of the pons Varolii, while it shows the union of the crura cerebri, cerebelli, and pons Varolii, also shows the white medullary tracts which extend from the crura cerebri through the pons Varolii, to the corpora pyramidalia; a little higher up, part of these striæ pass through the LOCUS NIGER CRURUM CEREBRI. We see also the transverse fibres of the medullary and cineritious substance, which make a right angle with those longitudinal tracts. On the whole, though the pons Varolii differs in form and place from the commissura magna cerebri, yet, I am of opinion, that it stands in the same relation to the lateral portions of the cerebellum, that the corpus callosum does to the cerebrum. That it is the great commissure of the cerebellum, uniting its lateral parts, and associating the two organs.

Anatomists have sought to explain a very curious phenomenon, by supposing that there is a decussation of the nervous filaments in the nodus or pons. It has often happened that an injury to the one side of the brain, an ulcer or tumour on one side, caused a loss of power in the opposite side of the body †, and the latest authority we have ‡ proves that a tumour on the one side of the pons Varolii, will produce an effect on the other side of the body. But no decussation can be observed; fibres, as I have said, run

* Some have divided the surface of the pons Varolii, into three divisions or bands: 1. The superior band, which winds round to embrace the crura cerebri; 2. the middle band, and 3d. the inferior band, the fibres of which intermingle with those of the crura cerebelli. They likewise subdivide the crura cerebelli; and that part which we have called corpus restiforme, has been named *pedoncule inferieure* of the crura cerebelli. But these are unmeaning minutiæ, the attention to which has of late retarded the improvement of useful knowledge.

† The observation has descended from *Hippocrates*, and the explanation that it depends on a descussation of the roots of the nerves is from *Aretæus*.

‡ Medico-Chirur. Transactions, VII.

across like commissures, but the tract of matter is direct and parallel, not oblique.

I am tempted to think there must remain much obscurity on this subject of the decussation of the fibres of the brain, or origin of nerves. I have found that the effect is not constant. An ulcer in the hemisphere of the cerebrum produced weakness in the same side; and in one well marked case of hydrocephalus, when the brain on dissection was equally affected on both sides, the one side of the body was convulsed and drawn up, and the other side motionless. This is not a singular occurrence; I have seen the eyes, face, and tongue in perpetual motion; but the action entirely on one side, the paralysis on the other, while both lateral ventricles were full of water, and the disorder of the brain, as seen on dissection, equally affecting both sides of the organ.

### MEDULLA OBLONGATA.

The medulla oblongata is the prolongation of the substance of the crura cerebri and cerebelli, from the pons Varolii; it is consequently the continuation of the encephalon, which, after giving off the nerves that pass through the foramina of the skull, enters the canal of the spine to supply the spinal nerves. The medulla oblongata is marked at its upper end by a deep sulcus dividing it from the pons Varolii; but towards the spinal cavity it decreases in thickness, and there is no natural distinction or sulcus to mark the point where the medulla oblongata ends, and the medulla spinalis begins; nor perhaps is the medulla oblongata to be considered in any other light than as the beginning of the spinal marrow. When it passes the foramen magnum, it ceases to be called the medulla oblongata, and is more properly medulla spinalis.

We have to observe certain eminences upon the fore part of the medulla oblongata, viz. two corpora pyramidalia, and two corpora olivaria. The CORPORA PYRAMIDALIA, so called from their shape, are those in the middle. There is formed betwixt them and

the pons Varolii (being three tubercles placed together) a little sulcus, which some have called the FORAMEN CÆCUM. Betwixt these eminences called pyramidalia, there is a longitudinal fissure, in the bottom of which there may be observed transverse little cords, which are like commissures connectin the two sides of the medulla oblongata; and the corpora pyramidalia which are prolonged downwards, twist, and form a decussation.

The CORPORA OLIVARIA lie upon the outside of the corpora pyramidalia. They are distinct oval convexities rising from the fore and lateral parts of the medulla oblongata. They are of a very peculiar structure, for anatomists had observed a mixture of a yellow or cineritious-coloured matter in them; but Vicq d'Azyr has described a regular oval medullary substance, or body surrounded with cineritious-coloured matter, like a miniature representation of the cerebrum itself; he calls it CORPUS DENTATUM EMINENTIÆ OLIVARIS.

The CORPORA RESTIFORMIA are the projections or cords behind the corpora olivaria, which come down from the crura cerebelli. (Betwixt this column of nervous substance, and the corpus olivare, there is a cord or column which gives origin to the nerves of respiration.) The corpus restiforme, as it is called, if by that is meant the posterior portion of nervous matter, which goes down from the cerebellum to the medulla spinalis, is double, or forms two columns distinct on the posterior surface of the medulla oblongata.

### MEDULLA SPINALIS.

The medulla spinalis is certainly, in part at least, an elongation of the brain. Its name implies its situation, that it is contained within the tube of the spine. Though chiefly composed of medullary matter, it is not entirely so; for there is an irregular, central, cineritious substance, through its whole extent, having something of a crucial form when a section is

made of it.* There are continued down from the calamus scriptorius behind, and the rima, formed by the corpora pyramidalia, before, two fissures which divide the spinal marrow into lateral portions. On the back part, however, the fissure is less distinguishable. Into the anterior one the little vessels penetrate to supply the cineritious matter with blood. The two lateral portions are divided into an anterior and posterior portion, so that this prolongation has four distinct portions very distinctly seen; but that there are other columns of different functions in the composition of the spinal marrow, I have given reasons to believe in the introduction.

The tube of the vertebræ is connected by a strong ligamentous sheath, which runs down the whole length within the tube. The dura mater, after lining the internal surface of the cranium, goes out by the great foramen, and forms a kind of funnel; at the occipital foramen it is united firmly to the ligaments. Further down, however, it forms a separate tube. The tunica arachnoidea again adheres loosely to the medullary matter of the spinal marrow, having a kind of secretion within it, while the pia mater closely embraces, and is intimately united to it.

Through the whole length of the spinal marrow the arachnoid membrane forms a ligamentous connection betwixt the medullary matter and the sheath or theca. A firm slip passes betwixt the roots of the nerves, and being tucked in the form of acute processes at distinct intervals to the sheath, it assumes the form of the teeth of a saw. It is from this pointed appearance that it is called the Ligamentum Denticulatum, or Dentatum.

Laying aside authorities, and only contemplating the dissection of the medulla oblongata and medulla spinalis, I would describe them as a great column continued from the brain, and lying embraced and protected by a sort of continued skull, the spinal

* The surface of the spinal marrow has also been observed to be of a darker colour, and in large animals cineritious. (Dr. Monro's Nervous System.)

tube. This column consists of lesser columns, so that it resembles a Gothic pillar. These different columns, as I have already expressed my opinion, are distinct organs, and give rise to nerves, which are possessed of powers which correspond with the origin or connection of their roots.

### SCHEME AND GENERAL DESCRIPTION OF THE ORIGIN OF THE NERVES OF THE ENCEPHALON AND SPINE.

In enumerating the nerves which pass from the cranium, I must now keep to the old way of Willis, counting only nine nerves of the encephalon. Because this is a natural method, and can never be entirely exploded. When we open the cranium and look to the nerves, we see them coming off, and taking their course exactly as Willis described them. His enumeration serves the purposes of dissection, therefore I shall first present them according to his arrangement, only reminding my reader, that nerves of very distinct offices are, in this arrangement, bound together, and take their course through the same foramina.

From the olfactory nerve to that which passes out betwixt the cranium and first vertebra, there are nine nerves.

| | |
|---|---|
| 1st pair.— Olfactory nerves. | *Carunculæ mamillares Math.* de Grad. *Processus ad nares.* Gonth d'Andernac.<br>$8^{um}$ par Spigel.<br>1st pair of Willis. |
| 2d pair.— Optic nerves. | *Nervus visivus seu visorius.* Carpi.<br>$1^{m}$ *par antiquorum.*<br>2d pair of Willis. |
| 3d pair.—Motores oculorum | $2^{um}$ par Fallop. et Vesal.<br>Nerfs moteurs communs des yeux. Winslow.<br>3d pair of Willis. |
| 4th pair.—Trochleares. | *Minor propago* $3^{ii}$ *Paris, id est* $5^{i}$ *recentiorum, Fallop.*<br>*Gracilior radix* $3^{ii}$ *Paris, id est 5 recentiorum.* Vesal.<br>*Nervus qui prope nates oritur.* — Eustach.<br>$9^{um}$ par Cortes: et Columb.<br>4th pair; or, pathetic nerves of Willis. |

| | | |
|---|---|---|
| 5th pair.— Trigemini. Symmetrical nerve of the head, answering to the spinal nerves. | | *Nervus anonymus trigeminus multorum.*<br>$3^{um}$ par Fallop. et Vesal.<br>5th pair of Willis.<br>Trijumeaux of Winslow. |
| 6th pair.— Abductores. | | $4^{um}$ par Fallop.<br>*Radix gracilior* $5^{i}$ *Paris, id est* $7^{i}$ *recentiorum Vesal.*<br>*Par oculis prospiciens.*<br>$8^{um}$ par Casp. Bauhini.<br>6th pair of Willis.<br>Nerfs oculo-musculaires, ou moteurs externes de Winslow. |
| 7thpair. | Auditory nerves. | $2^{um}$ par Alexand. Benedict.<br>$4^{um}$ par Carol. Stephan.<br>$5^{um}$ par Vesal. et aliorum.<br>$6^{um}$ par V. Horne.<br>Portia mollis, of the Moderns. |
| | Nervus communicans faciei. Muscular, or motor nerve of the face. Respiratory nerve of the face. | *Distinctus a molli nervus.* Fallop.<br>*Portio ut præcedens* $5^{i}$ *Paris id est* $7^{i}$ *recentiorum.* Vesal.<br>Portio dura, of the Moderns.<br>Le petit sympathique, of Winslow.<br>Facial nerve. |
| 8th pair. Grand respiratory nerve. | Glosso-pharyngeus. | *Qui ad musculos linguæ et faucium tendet.* Fallop.<br>Le rameau lingual de la $8^{e}$ paire of Winslow.<br>8th pair d'Andersch.<br>Superior fasciculus of the 8th pair of Willis.<br>*Glosso-Pharyngeus.* Haller. |
| | Par vagum. | *Nervus sextus* Galeni *et aliorum.*<br>$5^{a}$ *conjugatio* Carol. Stephen.<br>$7^{um}$ par Alex. Benedict.<br>$6^{um}$ par Casp. Bauhini.<br>$9^{um}$ par Bidloo. et Andersch.<br>8th pair of Willis.<br>Lè moyen sympathique of Winslow. |
| | Spinal accessory nerve. | The spinal nerve. |
| 9th pair.— Lingual. | | $7^{um}$ par Fallop. Vesal. *et aliorum.*<br>$11^{um}$ par Bidloo.<br>$10^{um}$ par Andersch.<br>*Par linguale medium, vel nervus lingualis medius.*— Haller. Soemmerring *et aliorum.*<br>The hypoglossal *sub-lingual*, or gustatory.<br>The 9th pair of Willis. |

| | |
|---|---|
| 10th pair—Symmetrical and 1st spinal nerve. Sub-occipital nerve. | 10th pair of Willis. 1st spinal, or cervical nerve of Haller. I count this the first cervical nerve. |

FIRST PAIR; OR, OLFACTORY NERVES.

The olfactory nerve is soft and pulpy, and soon resolved by putrefaction; therefore, we should not be surprised that it was neglected by the ancients. * It adheres firmly to the lower surface of the anterior lobe of the brain, but it does not take its origin here. It is of a triangular shape, as if moulded to the sulcus in which it lies; by being sometimes sunk into the sulcus more or less on one side than the other, it has the appearance of being larger on one side than the other. It takes its origin by three medullary tracts †; 1st, From the corpus striatum; 2d, From the medullary matter of the anterior lobe; 3d, From the fore and under part of the corpus callosum. ‡ When a section is made of it, we observe in it a cineritious portion.

Towards the fore part, this nerve expands into a bulbous oval lobe, which consists of a semi-transparent cineritious substance. This lies upon the cribriform plate, and from it are sent down the nerves

* The olfactory nerve is in brutes a large prolongation of the substance of the brain, and is the proper mamillary processes. Their olfactory nerves have a cavity or ventricle in them, and it was natural for the ancients to imagine that the pituita of the brain was from this strained through the cribriform plate into the nose. Vesalius proved the absurdity of this opinion; it was, however, revived by Dulaurens. But Willis is not much better, when he describes the proper use of these nerves. He supposed the cribriform plate of the æthmoid bone to prevent bodies from passing up into the brain ("ne quid asperi aut molesti cum illis una ad cere-"brum feratur"); while the lymph in those nerves corrected the too pungent odours; "odorum species demulcere, easque sensorio "quadantenus præparare."

† Or we say that the external root generally splits, having two fasciculi. See Prochaska, tab. 1. Scarpa Annot. Anat. p. 106.

‡ Vicq d'Azyr, M. de l'Acad. Roy. 1781.—"Breviores fibræ "medullares cum longioribus exterioribus connexæ nonnunquam "cineream particulam excipiunt." Soemmerring.

which expand upon the membrane of the nose, and compose the organ of smelling. *

SECOND PAIR; OR OPTIC NERVES. †

The optic nerves arise from the posterior part of the optic thalami, and from the tubercula quadrigemina or nates. When we trace the optic nerves backwards into the tractus opticus, we find them adhering to the *tuber* cinerius, or layer of grey matter, then taking a circle round the crura cerebri, then enlarging, each forms a tubercle towards the back part of the thalamus opticus, and afterwards unites with the posterior tubercle of the thalamus opticus; at the same time a division stretches further backwards to the testes, while betwixt the posterior tubercle of the thalamus opticus and the nates, there is also a communication. When those tubercles are fairly exposed by separating the middle lobes of the brain, and dissecting away the tunica arachnoides and pia mater, they are seen smooth, and formed of medullary matter; which is uniformly continued from the one to the other, following their gentle convexities with an uninterrupted surface. Within those tubercles is a mixture of cineritious and medullary matter, and especially, there is a distinct streak which passes from the tractus opticus to the nates. ‡

Tracing the optic nerves from their origin in the brain towards their exit from the skull, we find them approaching gradually, and uniting just before the corpora albicantia and the infundibulum.

Since the days of Galen, it has been a disputed point, whether there is a union simply of the nerves or a decussation. Fishes have the nerve arising from one side of the brain, passing to the eye of the other

* Duverney has shewn us, that those nerves passing through the cribriform plate become firm nerves, like those in the other parts of the body. They are to be seen by tearing the membrane of the nose from the bone.

† The optic nerves were the first pair of Galen and many of the older anatomists, they being ignorant of the olfactory nerves.

‡ Santorini tab. Scarpa Anatom. Annotat. p. 106.

side: they cross, but they do not unite. Birds have but one optic nerve arising from the brain, which splits and forms the right and left optic nerves. Vesalius dissected a young man at Padua, who had lost his eye a year before: at the same time he dissected a woman, whose eye had been lost a long while. In the latter he found the nerve of that side smaller, firmer, and of a reddish colour, through all its extent. In the young man he observed no effect upon the nerve. He also gives a plate descriptive of an instance in which he found the optic nerves pass on to the eyes of the same side from which they take their origin, without adhering at all.

Valverda, a physician of Spain, who travelled into Italy, and studied the works of Vesalius and human dissection, says, that at Venice, he had frequent opportunities of assuring himself that there was no decussation; for robbers were punished for the first offence by losing one of their eyes; and for the second by death. Riolanus, Rolefinkius, and Santorini, give observations of the nerve of the injured eye being small and shrivelled, and of their having traced them past their union to the same side of the brain with the eye to which they belonged. Vicq d'Azyr, who, of all authors, I conceive to be the best authority upon such subjects, is decidedly of opinion that there is no decussation. Zinn also agrees with the opinion of Galen, that there is an adhesion and intimate union of substance, but no crossing of the nerves. Soemmerring deems it sufficient to point out the authorities on both sides of the question, while he has no decided opinion whether there be a perfect decussation or not.* Porterfield, while he allows the intimate union of the optic nerves, has several observations, proving that they have no intersection or decussation.

Sabbatier, encouraged by the authority of Morgagni, says, that he could trace the affection of the

* "Ergo utrum omnes nervorum fibræ, an quædam tantum "mutuo se secent, certe statui nequit."

nerve of the injured eye no farther than to the union. He discredits the accounts of their having been traced to the same side of the brain, and believes the assertions to be the consequence of previous opinion and prejudice. — There are certain observations of Valsalva, Cheselden, and Petit, which seem to prove, that where the brain is injured, it is the eye of the opposite side that is affected. After their union the optic nerves are much contracted in diameter; still the optic nerve is the largest of the head excepting the fifth pair. It is the firmest of all the nerves of the senses, but softer than the other nerves. *

What remains to be said of the optic nerves, falls more naturally to be treated of when speaking of the organ of vision.

### THIRD PAIR OF NERVES; MOTORES OCULORUM.

The third pair of nerves arise from the internal margin of the crura cerebri, and the perforated medullary matter which is betwixt the crura. The delicate filaments of this nerve cannot be traced far into the substance of the brain, but still we may observe them spreading their filaments, and traversing the dark-coloured spot which we have already mentioned to be visible in the crura cerebri. Some anatomists have said, that the third pair of nerves had an origin also from the nates and testes. Ridley describes them as rising from the pons Varolii.† Malacarne describes an accessary filament to thi third pair from the crura cerebelli.‡

In relation to the arteries, those nerves are betwixt the posterior artery of the cerebrum, arising from the division of the basilar artery and the anterior artery

* Soemmerring.

† They seem to come from the angle betwixt the crura cerebri and pons Varolii. They are flat near their origin, but become round and firm.

‡ See Desmoulins, Anatomie des Systèmes Nerveux des Ani maux à Vertèbres. Atlas, pl. xiii. fig. 1. and 3. z.

of the cerebellum. * They diverge from each other as they proceed forwards, and each penetrates under the anterior point of the tentorium by the side of the cavernous sinus, and passes through the foramen lacerum. In the general description it is sufficient to say, that they are distributed in common to all the muscles of the eye.

### THE FOURTH PAIR OF NERVES.

The fourth pair of nerves, pathetici, or trochleares, are the smallest nerves of the encephalon, being not much larger than a sewing thread. This nerve comes out from betwixt the cerebrum and cerebellum, passes by the side of the pons Varolii, and after a long course pierces the dura mater behind the clynoid process, runs along for some way in a canal or sheath, formed by the dura mater; it then passes above the cavernous sinus, continues its course onwards through the foramen lacerum to the orbit, and is finally appropriated to the superior oblique muscle of the eye.

The origin of the fourth pair, if we take the descriptions of authors, seems to have a much greater variety than any of the other nerves; so that it is common to say, the fourth pair of nerves arises about the region of the nates and testes. † It is affirmed, that the trochlearis arises sometimes by two filaments, but more commonly by one undivided root. ‡ This

* "Cette disposition peut expliquer pourquoi on éprouve tant "de pésanteur aux yeux aux approches du sommeil, dans l'ivresse "et dans certains espèces de fièvre." Sabbatier. This is a mechanical and a most improbable way of accounting for such an effect.

† "Pone corpora bigemina posteriora mox paulo superius, mox "paulo inferius, mox magis exteriora, mox magis interiora versus "radice simplici, duplici, triplici, quin et quadruplici oritur.— "Nonnunquam origo ejus in cerebri valvula, nonnunquam in ipso "frenulo patet ut humore ventriculi quarti alluatur." Soemmerring, vol. iv. p. 209.

‡ Santorini says, they have three roots or little fasciculi. Wrisberg, following Vieussens, says, the fourth pair arises from the valvula cerebri. Vicq d'Azyr. See Haller, fas. vii. tab. 3. "Origo "alius simplex est, alius duplex; quando simplex est, a processu "a cerebello ad testes exterius prodit, quam est transversa stria, "quæ eos processus conjungit." Haller, Phys. vol. iv. p. 208.

root, according to Vicq d'Azyr, is seen to emerge from a point betwixt the medullary lamina of the cerebellum, or valvula Vieussenii, and the lower part of the tubercula quadrigemina. * My opinion is, as I have elsewhere expressed, that it comes from the upper part of the spinal marrow, and that the reason of this nerve taking a course different from the other nerves of the encephalon, is, because it is connected with that column of the spinal marrow which orders the actions of respiration.

### FIFTH PAIR OF NERVES; GRAND SENSITIVE NERVE OF THE HEAD AND FACE.

The fifth nerve of the brain arises from the fore and lowest part of the crura cerebelli, where they unite with the pons Varolii. The origin of this nerve may be divided into two portions; an anterior is small, and somewhat elevated above the other. The posterior part of this origin takes its rise a little lower than the anterior part, and is broader and flatter. These two origins of the nerve are connected by a cellular membrane, and have betwixt them a little groove, in which not unfrequently an artery creeps.† According to Santorini the anterior of these divisions is formed by the transverse fibres of the pons Varolii, and the posterior by the crura cerebelli. ‡ Vicq d'Azyr could never, except in one dissection, perceive that any of its fibres arose from the pons

* "Et souvent ils se confondent avec un tractus medullaire "placé transversalement au-dessus de la valvule du cerveau." Vicq d'Azyr. This nerve, says he, cannot be followed into the anterior part of the brain from its extreme delicacy, and because it is formed from the medullary substance itself, without the admixture of filaments to give it strength. He quotes those words of Soemmerring: "Continua medulla oritur."

† Vicq d'Azyr distinguished the roots into "la portion filamen-"teuse, et la portion arondie qui a la consistence d'un gros nerf."

‡ See two wood-engravings at pp. 387 and 388, which exhibit the exact origins of the 5th pair. Santorinus. Wrisberg de quinto p. Nervor. Scarpa Anat. Annotat. p. 107.

Varolii.* The nerve of the right side has been observed sometimes larger than that of the left.

This fifth nerve, the largest of the skull, passing forwards and downwards, slips in betwixt the lamina of the dura mater, opposite to the point of the pars petrosa of the temporal bone. It is here firmly attached to the dura mater, and forms a flat irregular ganglion. This ganglion † is formed entirely by the posterior portion of the nerve; the anterior portion passes the ganglion, and enters the foramen ovale. From this great nerve there pass out three branches, hence the term trigeminus is given to the fifth: — 1st, One to the socket of the eye and forehead, through the foramen lacerum; 2d, One to the upper jaw and face, through the foramen rotundum; and 3d, One to the lower jaw and tongue, passing through the foramen ovale. As I have explained in the introduction to the nerves, this fifth nerve of Willis is the upper or anterior of the regular system of nerves. It is to the head what the spinal nerves are to the body. It is a double nerve, bestowing sensibility on the head and face, and supplying muscular branches to the muscles of the jaw.

### SIXTH PAIR OF NERVES; OR, ABDUCENTES.‡

The sixth nerve of the skull seems to arise from betwixt the pons Varolii and medulla oblongata. In the origin of its fibres it has, however, much variety; and authors differ very much in this point of the description.§ We may say, however, that the sixth pair of nerves arise from the corpora pyramidalia. — Sometimes the nerve rises in two branches, which do not unite until they are entering into the cavernous

* " Oritur e nodo cerebri, prope cerebellum duabus partibus, &c." Soemmerring.

† Viz. the Gasserian ganglion.

‡ Or, motores externi.

§ Simple as the anatomy of the nerve is, Vieussens, Morgagni, Lieutaud, Winslow, Sabbatier — all differ in their account of the origin of this nerve in some little circumstance; and Vicq d'Azyr gives six varieties of it.

sinus. * The sixth nerve is in size somewhat betwixt the third and fourth: it passes forward under the pons Varolii, until near the lateral and lower part of the body of the sphenoid bone: it thence continues its route forwards and downwards by the side of the carotid artery, through the cavernous sinus: here it seems increased in size. It gives off that small twig which anatomists account the beginning of the great sympathetic nerve. This communication often consists of two nerves; and there is seated on the carotid artery a small square ganglion, which sends branches to the sixth, fifth, and sympathetic. The sixth nerve, after giving off this communication, passes on through the foramen lacerum to the abductor muscle of the eye.

### SEVENTH PAIR OF NERVES; OR, AUDITORY.

The seventh nerve arises from the posterior and lateral part of the pons Varolii, at the point where it is joined by the crura cerebelli.

But this seventh pair of Willis consists of two parts; the facial nerve or portio dura, and the auditory or portio mollis; the last is the larger and posterior portion. †

The PORTIO DURA comes out from the fossa formed betwixt the pons Varolii, corpus olivare, and corpus restiforme; ‡ and upon a more careful examination we find it rising distinctly from the superior point of that column of the spinal marrow, which gives origin to the par vagum, spinal accessory, or glosso-pharyngeal nerves.

The origin of the portio mollis, of the seventh pair, is to be traced from the fore part of the fourth ventricle. § We observe passing obliquely upwards from

* Sabbattier. Scarpa loc. cit.

† And we may add a third portion; the portio media of Wrisberg.

‡ "Fosse de l'éminence olivare," of Vicq d'Azyr.

§ Prochaska, speaking of the fourth ventricle, continues thus:— "Super has ultimas eminentias solent medullares candicantes quasi "fibræ decurrere, a quibus propric originem portionis mollis ner- "vorum auditoriorum saltem pro parte deducunt." (Ridley, Hal-

the calamus scriptorius several medullary striæ, which vary in number from two to seven, and are sometimes very indistinct.* To these are added certain fibres arising from the pons Varolii, which altogether constitute the portio mollis. The whole of this portio mollis is larger than the third nerve, firmer than the first, but less so than the second pair. It forms a kind of groove which receives the portio dura. They are divided by a small artery which comes off from the basilar to supply the ear. The portio mollis and portio dura entering the meatus auditorius internus of the petrous bone, the former is divided into four portions which pass to the several parts of the internal ear, while the latter traverses the petrous portion, and comes out by the stylo-mastoid foramen behind the ear, spreads upon the cheek, and forms the principal nerve of the face: that nerve which commands the muscles of the face.

### EIGHTH PAIR OF NERVES.

To understand a very intricate demonstration, it is necessary to recollect that the eighth pair of nerves, as they have a relation to the brain, consist of three distinct nerves. — These are, 1st, The GLOSSO-PHARYNGEAL NERVE; 2d, The PAR VAGUM; 3d, The SPINAL ACCESSORY. — Taken altogether, they arise from the superior and lateral part of the medulla

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ler, Lobstein, cum per antiquo auctore Piccolhomini et etiam recentissimus Soemmerring.—"Ego postquam multoties in lineas illas "medullares in quarto ventriculo inquisivissem, dicere possum, "non semper illas in originem nervi acustici mollis terminare; non- "nunquam enim paulo supra nonnunquam paulo infra desinunt, "aliquando in uno latere, et haud raro utrinque desiderantur, ita "ut ex his observationibus persuadear illas medullares quarti ven- "triculi strias ad originem portionis mollis nervi acustici minime "essentiales esse." Prochaska, tab. iii. f. f. Scarp. loc. cit.

* It is a curious circumstance, should future observation confirm it, which has been mentioned by Santorini, that those origins of the auditory nerve have been observed particularly strong in a blind man, whose hearing had been very acute.

oblongata, from that part which I consider the respiratory column of the spinal marrow.

The GLOSSO-PHARYNGEAL NERVE is only distinguished within the skull as a larger filament of the eighth pair; it is, however, distinct in its course from the origin of the point where it pierces the dura mater; it is the uppermost of the fibres of this pair of nerves. Sometimes there is a very delicate filament running parallel with its lower edge, which belongs to it. It has the same origin with the fibres of the par vagum.*

The PAR VAGUM is composed of ten or twelve very small filaments, which are sometimes united into three or four fasciculi. These filaments arise from the outer border of the corpus olivare, or from the lateral part of the medulla oblongata. † A few fibres are to be traced from the side of the calamus scriptorius of the fourth ventricle.

The SPINAL ACCESSORY NERVE comes up from the spine to join the par vagum; it begins by small twigs from the middle column of the spinal marrow below the roots of the fourth, fifth, sixth, and even the seventh cervical nerves. In the size, length, and origin of those little slips, there is much variety. As the nerve ascends to the top of the spine, it connects itself with the sub-occipital nerve; it then passes behind the trunk of the vertebral artery, approaches the par vagum, and receives some filaments from the medulla oblongata. — Those three nerves, the glosso-pharyngeal, par vagum, and accessory nerves, in their passage out of the skull are connected

* "Nervus glosso-pharyngeus fasciculo mox una, mox duabus, " quatuor, quinque fibris composito oritur ex summa atque priore " parte medullæ pone corpora olivaria nervum facialem inter atque " nervum vagum, nonnunquam etiam ex quarto ventriculo vel ex " cruribus cerebelli ad spinæ medullam, nonnunquam sub posteriori " sulco nervi vagi, deductus ab eo vel distinctius, vel obscurius " interposita arteria, vel vena, vel arteria et vena simul, vel parte " plexus choroidis, quid quod ipsa directione a nervo vago est dis- " tinctus." Soemmerring.

† Some filaments, according to Vieussens, Santorini, and Soemmerring, are derived from the side of the 4th ventricle.

in a very intricate way. They then separate from each other. The anterior branch, the glosso-pharyngeal nerve, goes to the tongue and pharynx; the middle nerve, the par vagum, has an extensive course through the body, and finally terminates in the stomach; the lowest nerve, the accessory, passing into the neck, perforates the mastoid muscle, and distributes its branches amongst the muscles of the shoulder.

### NINTH PAIR OF NERVES; OR, LINGUAL; THE MUSCULAR NERVE OF THE TONGUE.

The ninth nerve of the skull originates from betwixt the corpora pyramidalia, and olivaria; from that column which gives off all the motor nerves. It is composed of several little filaments; those unite into a fasciculus of a pyramidal shape: still those filaments do not form a nerve before perforating the dura mater, but pierce it severally*; they then unite and pass out of the skull by the condyloid foramen of the occipital bone; they are then connected with the eighth pair and ganglion of the sympathetic nerve. The final distribution of the nerve, is to the muscles of the tongue. †

### THE TENTH; OR, SUB-OCCIPITAL NERVE.

From is origin, its manner of passing betwixt the skull and first vertebra, and its distribution, it must be classed with the nerves of the spine. It is of the class of symmetrical nerves, being double in its roots, and performing the double office of giving sensibility and motion.

* The ninth pair of nerves often differ very much in one side from the other, in regard to the origin and number of those fasciculi.

† "Forsan etiam nimio sanguine plena arteria vertebrali pressus "læditur, ut inde hæsitantia atque resolutio linguæ ebriorum, ex "cerebri phlegmone insanientium, attonitorum explicari possit.— "Collapsa vero eadem arteria ex nimio sanguinis profluvio lingua "ob sanguinis forsan defectum resolvitur.—Ex ejusdem nervi "nexu cum nervis cervicalibus vocis jacturam post læsam spinalis "medullæ partem quæ in cervice est, explicarunt."

The nerves of the spine are divided into the eight cervical, twelve dorsal, five lumbar, five, and sometimes six or seven, sacral nerves. * Each of those thirty nerves arise in two fasciculi, one from the fore, and the other from the back part of the spinal marrow. They are to be traced a great way in the length of the spinal marrow before they pass the membranes. The posterior and anterior fasciculi penetrate the dura mater separately, and afterwards unite. The posterior fasciculi before they unite with the other, swell into a little ganglion. The posterior fasciculi of the cervical nerves communicate with each other by intermediate filaments. And these considerations carry us back to the view delivered in the introduction.

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## OF THE VEINS AND SINUSES OF THE BRAIN.

In proportion to the intensity with which the function of a part is performed is its supply of blood. The brain is very profusely supplied with blood, in so much, that it is estimated that four times more blood circulates here than in any proportionate weight of the body. This is the most moderate circulation, and it has been formed from a comparison of the quantity of blood circulating in the head, with that which circulates in the arm. Boerhaave and Kiel, comparing the area of the arteries of the cerebrum with that of the ascending aorta, made a most erroneous calculation of the proportion of blood circulating in the brain, compared with that of the rest of the body. Had they compared the quantity of blood within the head with that of the lungs, of the liver, of the spleen, or of the kidney, the difference would have been less striking.

* "Plerumque quinque sunt, nonnunquam sex, raro tres vel quatuor." Soemmerring.

Wherever there is great arterial vascularity, we are sure to find also peculiarities in the venous system of the part; wherever we find an accumulation of tortuous arteries passing to a gland, we shall also find the veins tortuous and large.

The following appear on the first view to be the most striking peculiarities in the veins of the brain; their size; the little connection they seem to have with the surrounding cellular membrane, and the inconsiderable support which they appear to receive from it; their having no valves; their being in their course distinct from the arteries; and lastly, their not being gathered into great trunks, but emptying themselves into the sinuses of the dura mater.

It is not easy to conceive how the veins of the brain should have been so much overlooked by the older anatomists; but from the dissections of Albinus, and the microscopical observations of Lieeuwenhoeck, we have authority for what is, perhaps, in itself sufficiently evident, that the veins of the surface of the brain are derived from minute ramifications conveyed in the delicate pia mater; and that these, as in the other parts of the body, proceed from the extremities of the arteries, without any apparent peculiarity in the connection betwixt the extremities of the arteries and the veins of the brain. *

I divide the veins of the brain into the external and internal, or those which emerge from its substance, and are seen upon the surface; and those which, coming chiefly from the sides of the ventricles, are convoluted in the plexus choroides, and terminate in the fourth sinus.

* The observation is trivial; but we must recollect, that Vesalius contradicted Galen, and affirmed, that the sinuses received also arteries which gave them their pulsation. This opinion was refuted by Fallopius, but adopted by Vieussens, Wepfer, and others, upon the idea of the facility with which injection passes from the arteries into the sinuses. See Ridley, cap. vi. de Cerebri Motu, ejusque Sinubus.

## OF THE VEINS WHICH ARE SEEN UPON THE SURFACE OF THE BRAIN.

Vicq d'Azyr has been minute in his attention to the veins of the surface of the brain. He confirmed the observation, that almost all the veins which pass into the longitudinal sinus, open in a direction contrary to the stream of blood in the sinus.* These superficial veins of the surface of the hemispheres, are in number generally from ten to fifteen on each side. They really do not seem to be worthy of the minute attention which Vicq d'Azyr has bestowed upon them : he has most carefully described each individual branch, and that not in general terms, but first those of the right, and then those of the left side. Now, although these veins do not enter the sinus opposed to each other, nor in pairs, still the irregularity is trifling, and, were it important, does not admit of description. Those veins do not lie in the sulci of the brain, but pass occasionally along the interstices, or over the convolutions of the brain; they take in general a course from before backwards, but previous to their entering the sinus, are turned forwards. We have already observed, that the pia mater and dura mater have no connection, but at the place where those veins enter the lamina of the dura mater; and here their connection is somewhat peculiar. It is not a simple adhesion of the pia mater and dura mater; but a white spongy substance seems to connect and strengthen them, and, when torn asunder,

* From Vicq d'Azyr's table we should be led to conclude, that the veins did not decidedly all open with their mouths opposed to the stream of blood. Ridley asserts, that one half open backwards. Santorini also observes great variation in the direction of these veins. Lower, while he observed this direction backwards, describes them, at the same time, as passing obliquely betwixt the coats, like the gall-duct in the intestine, or the ureters into the bladder. Sabbatier says decidedly, that they enter with their mouths opposed to the course of the blood in the sinus. From Malacarne, we should be led to conceive (what I believe to be the truth) that they open very irregularly.

it leaves a soft fatty kind of roughness upon the pia mater. These appear to me to be the same bodies which Ruysch so frequently mentions as little particles of fat, and which others have taken to be the glands of the pia mater.* Vicq d'Azyr, in his xxxiiid plate, fig. 14. has confounded them under the name of the glandulæ Pacchioni.† Of these veins lying upon the surface of the brain, there is one, or very often there are two large veins on each side, and which enter generally pretty far back in the sinus, and are somewhat peculiar from their greater size, and their semicircular course. These, from their state of dilatation, and the colour and fluidity of their blood, will be found in morbid dissection, to mark sufficiently, in many instances, the character of the venous system of the brain. There is again another vein somewhat peculiar in its course; whilst those take a superficial course, and are upon the level of the longitudinal sinus, it gathers its branches upon the internal flat surface of the left hemisphere, and rises so as to insinuate itself into the inferior part of the sinus.‡ All these veins of the surface of the cerebrum have very free inosculations with each other.

I cannot any where better observe the negligence of authors, in regard to the glandulæ Pacchioni, than when speaking of the mouths of those veins which open into the great longitudinal sinus.

* "Portio piæ matris in liquore, cujus superficies exterior ob-"sita variis particulis prominentibus exiguis, quas pro glandulis "habuerunt nonnulli: cum autem sint diversæ formæ, et colore "pinguidinem repræsentent, pro pinguidine potius illas habeo, "præsertim cum inter duplicaturam piæ matris aliquoties pingui-"dinem invenerim." Thesaurus Anat. ix. N. xlii. Epist. ix. p. 8. Thes. v. No. 1.

† We see also what he says in the Acad. of Sciences, An. 1781; p. 502. "Elles étoient plus ou moins recouvertes, vers leur inser-"tion par les glandules de Pacchioni: les ayant examinés dans "plusieurs sujets, j'ai observé qu'elles étoient a peu-pres, de "chaque côté au nombre de dix, douze, ou quinze." Ridley calls these "carnous adnescences," betwixt the membranes, p. 8. As to the glands which Willis affirms to be scattered over the tunica arachnoides, I could never see them. Ridley.

‡ Vicq d'Azyr.

I cannot help thinking, that many of our best authors have overlooked entirely the importance of the glandulæ Pacchioni; and many also have been entirely ignorant of them. We have already mentioned, that a few small bodies, by no means constant or regular, were to be seen upon the external surface of the dura mater, in the course of the longitudinal sinus, or at no great distance from it. We have mentioned also those fatty-like adhesions of the roots of the veins, as they enter the sinus, and which rather belong to the pia mater. Both these are called the glandulæ Pacchioni improperly. The bodies which engaged Pacchioni and Fautonus in such violent disputes, are seen on the inside of the longitudinal sinus, and are connected with the openings of the veins *; they appear of a fleshy colour, projecting like papillæ, or like the granulations of a sore. Pacchioni says, "Ovorum instar bombycinorum appa-"rent," which describes their conglobate appearance; but they are of a pale fleshy colour, which Pacchioni says is owing to their being surrounded with muscular fibres. The preparation from which Pacchioni had taken his plate, was previously macerated in vinegar. These bodies being soft and vas-

* "In longitudinali sinu, immediate, sub membranosis expan-"sionibus, in areolis chordarum Willisianarum, quin et supra eas-"dem chordas consitæ sunt innumeræ glandulæ conglobatæ, pro-"pria, et tenuissima membrana, veluti in sacculo conclusæ; quæ "racematim ut plurimum coeunt; raro sparsim disponuntur: hæ "glandulæ utrinque ad latera falcis messoriæ, ab ejusdem apice ad "basis usque posticam partem miro prope modum artificio pro-"cedentes, dorso lacertorum accumbunt, et partim ab horum fibris, "partim ab iis, quæ a chordis emergunt, firmantur, atque invicem "alligantur, ita ut non nisi lacerat acu disjungi possint." Vide Pacchioni, p. 126.

"Sinu longitudinali aperto, in conspectum veniunt corpuscula "rotunda, & subrotunda, milii forma, (a clariss. viro Pacchiono de-"tecta) hæc magnitudinem aciculæ vulgaris caput haud superant, "nisi per microscopium introspiciantur, aut ex duobus corpusculis "combinentur." Ruysch, Thes. vii. No. xxxiv. From this we see how various the size of these bodies is. In the next paragraph he observes, "Vix et ne vix quidem ullum ex dictis corpusculis "videre potest."

cular, have allowed the minute injection to transude in some of the experiments of anatomists, which has given rise to the opinion of the actual communication of the arteries of the dura mater with the sinuses. As to their use *, I am in considerable doubt. Joan. Fautonus (in his letters to Pacchioni) conceives that they give out a fluid into the sinus, to dilute the venous blood. † Pacchioni describes ducts passing from them to the pia mater, (which are those connections that we have already remarked,) and conceives that they lubricate the surface, or communicate with the substance of the brain; and that they are pressed, and their secretion promoted by the motion of the chordæ Willisianæ, and the action of the dura mater. ‡

I should rather conceive that they had a valvular action of the mouths of the veins; they project from the mouths of the veins in the sinus, and the blood passing from the veins must filter through them, and be checked in its retrograde course. This check we know to be very necessary, since the blood flows backwards through the sinuses with a powerful impetus. As these bodies differ very much in the variety of subjects, they must sometimes impede the free egress of the blood from the veins of the cerebrum into the longitudinal sinus, and cause disease, especially as they are softer and larger in old men. § At all

* It is curious that these bodies are confined to the longitudinal sinus. " Mirum, & æque animadversione dignum est, hasce glan-" dulas ad solius longitudinalis sinus latera reperiri cum in laterali-" bus sinibus vel nunquam, vel raro admodum per pauca earundem " vestigia adnotentur, ubi præsertim præfati canales deorsum incli-" nare incipiunt, antequam ab interseptorum dorso discedant." Pacchioni, p. 127.

† " Ego aqueum humorem in glandulis egregari, fluere lym-" pham in tubulis, quos tecum lymphaticos appello, nunquam ne-" gaverim, sed liquidi fluxum ab utrisque versus sinum magis, " quam versus ambitum cerebri verisimilem, magisque naturæ legi-" bus consonum esse affirmo. Fautonus Epist. D. A. Pacch. Oper. " Pacch. 177."

‡ " Ex iis autem in minimum quidem vasculum lymphaticum prodire conspicere potui." Ruysch.

§ " Fibris carneis tenuissimis circumambiuntur singulæ, unde

events, they are too much overlooked in morbid dissection.

The veins which answer to the arteria corporis callosi, and which are seen lying upon the corpus callosum in a very fine cellular membrane, rise and pass into the inferior longitudinal sinus, that sinus which is formed in the laminæ of the inferior edge of the falx.

## OF THE INTERNAL VEINS OF THE BRAIN AND OF THE CHOROID PLEXUS.

Under this title of the internal veins of the brain, the choroid plexus comes naturally to be considered. The most remarkable thing in the ventricles of the brain is, the choroid plexus. The lining membrane of these cavities is extremely thin and smooth, insomuch, that some anatomists have denied its existence; but through the whole ventricle there run certain folds or plaits of this membrane, which are so loaded with vessels as to resemble a fleshy substance, and thus lose their resemblance of the lining membrane. The plaits, before they are unravelled, look like masses of tortuous vessels, lying loose and unconnected in the bottom of the ventricles.

The largest portion of each choroid plexus comes up from the inferior horn of the lateral ventricle, and runs forward in a direction to the anterior horn. It lies in the groove, betwixt the thalamus nervi optici and corpus straitum: and covers the tenia semicircularis geminum. The two plexus of the lateral ventricles unite under the anterior crus of the fornix, and form a small plexus which is continued upon the inferior surface of the velum interpositum, and even into the third ventricle. Again, there is another plexus which lies in the fourth ventricle. Vicq

"colorem carneo-pallidum nancisci videntur: in senibus vero, in "quibus hujusmodi fibræ enervatæ nimis laxantur, et ferme dispa-"rent, glandulæ albescentes, & magis turgidæ cernuntur: quod, "& in hydrocephalicis, comatosis, & id genus aliis observari posse "arbitrarer." Pacchioni Oper. p. 126, 127.

d'Azyr describes, as occasionally occurring, little insulated plexuses attached to the veins, branching on the corpora striata.*

Very often we find the portion of the plexus, which is ascending from the lateral ventricle, thicker and firmer than natural, and sometimes it has in it small bodies like glands, which, however, are of the nature of hydatids or vesicles, and are a production of disease or over excitement.† A foolish notion prevailed, that the blood accumulated in these convoluted vessels, occasioned such a gentle continued heat as favoured the circulation of the spirits through the cavities of the brain, and preserved the fluidity of the water of the ventricle.‡ Great variety of opinions have prevailed regarding the structure of those bodies. We see them consisting of knots of convoluted vessels; chiefly veins; or these at least are most evident from their size, and the colour of their blood. It is these convolutions of vessels, which are by many good anatomists described as glands. Varolius, Sylvius, Wharton, Willis, Santorini, and Lieutaud consider them as such.§ Three sets of ARTERIES pass up

* "Sur le côte des ventricules latéraux, j'ai quelquefois observé "de petits plexus choroides isolés, que accompagnoient quelque-"fois de ces rameaux des veins de Galien, que l'on voit passer sous "le tænia semicircularis, et s'etendra sur le corps strié." Vicq d'Azyr, Memoir. l'Acad. Roy. 1781, p 540.

† The supposed glands of the plexus choroides were conceived to secrete the fluid of the ventricles. Where the plexus lies upon the posterior crura of the fornix, it is often diseased, having knots like glands, or, being raised into vesicles, like hydatids, "Eas "bullas humorem ventriculorum secernere olim conjectura fuit. "Verum vitio cum nascantur vix perpetuum habitum generare "idoneæ erunt." Haller tom. iv. 48.

‡ See Duverney, tom. i. p. 55. "Ut enim sanguis intra sinuum "cavitates aggestus, Balnei calidioris vicem prestat, quo spiritus "animales in extima et corticali cerebri parte uberius distillentur: "ita sanguis intra plexus hujus vasa exilia contentus, quo iidem "spiritus in penitiori ac medullari substantia idonei circulentur, "Balnei minoris, et magis temperati loco esse videtur." Willis Cerebri Anat. p. 47.

§ Galen gives a good description of the choroid plexus; he describes the innumerable veins of which it is composed, and their

to the PLEXUS CHOROIDES, from the base betwixt the crura of the brain; they come, 1st, from the curve of the internal carotid artery; 2d, from the communication betwixt the basilar and carotid artery; 3d, from the basilar artery and posterior part of the branch of communication. These arteries, which are small, are convoluted in their course and run into great minuteness * in the membrane, and their blood is returned by veins, which taking a very tortuous course, seem to entangle their branches, and form a confused mesh.

I conceive the use of these loose and vascular membranes, is to secrete the fluid of the cavities. They are undoubtedly the parts of the brain the most excitable, for if but a temporary change takes place in the circulation of the blood in the brain, it will upon dissection be manifested in the state of fulness of these veins, in the vesicles which are formed in their folds, and in the accumulation of fluid in the ventricles themselves.

The blood of the two plexuses of the lateral ventricles, and that of the third, is conveyed into the velum interpositum, or that membrane which stretches under the fornix, and over the third ventricle. The branches of veins also which extend themselves upon the sides of the lateral ventricles, and into the processus digitalis, being gathered together upon

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joining the fourth sinus by the vein which retains his name. Some have confused themselves with a passage of Ruysch. Thes. iii. No. lxv. &c. in which he is speaking of the choroid plexus, where it appears in the base of the skull from the bottom of the fourth ventricle. They have understood him to say, that the plexus was covered not with the pia mater, but with the tunica arachnoides, first described by Morgagni, and whose authority we may consult for much of this part of anatomy. Adversar. Anat. vi. Animad. 1. et sequent.

* "Huncce plexum nil esse nisi arteriolas, ad visam succosas, a "naturali constitutione arteriosa non nihil recedentes, mirumque "in modum contortas, serpentinoque modo reptantes, glandulasque "representantes." Ruysch, Thes. v. Asser. quartus, No. lxviii. Not. 2.

this membrane, open into the vena Galeni, or rather form it.

The most remarkable branches of veins in the lateral ventricle are these: a considerable vessel is seen to collect its branches upon the anterior part of the ventricle, and in the anterior sinus, or horn of the ventricle. This vein runs back towards the anterior crus of the fornix, and dips under it, just above the communication of the ventricles; and joins the veins in the velum of Haller. Other small veins are seen collecting their branches upon the corpora striata; and, passing under the centrum semi-circulare geminum, connect themselves with the plexus. Again several branches of veins are extended in the posterior part of the ventricle. These are from the medullary substance of the posterior lobe of the cerebrum. They pass under the posterior crus of the fornix and join the vena Galeni. Lastly, a vein remarkably tortuous, frequently full of blood, passes forward, and is seen at intervals in the plexus choroides. This vein, taking an acute turn, joins its fellow under the anterior crura of the fornix, and is reflected backwards and under the fornix, so as to form the beginning of the vena Galeni.

The VENA GALENI then is the great central vein of the brain. It stretches from the extremity of the fourth sinus into the internal part of the brain, to receive the blood from the membrane lining the ventricles,—from the substance of the brain,—from the plexus choroides,—and from the velum interpositum.* It lies under the posterior part of the corpus callosum, under the fornix and above the nates and testes. It is entangled in the velum itself. It consists of two great branches which lie parallel to each other, and which sometimes have the appearance of being

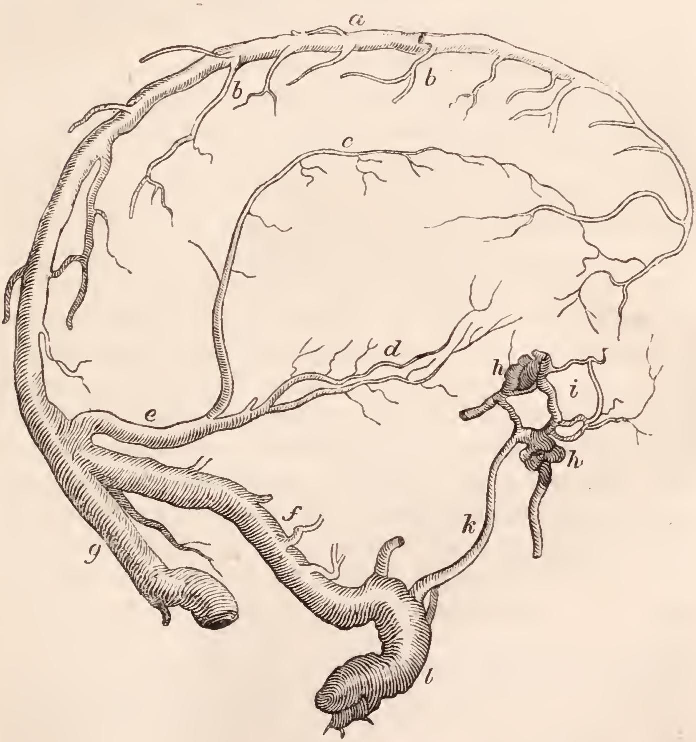
* The velum lying upon the nates and testes, and adhering to them and the pineal gland; the vena Galeni receives here also veins from those bodies, and from the upper part of the cerebellum.

twisted, and these unite before they enter the fourth or strait sinus.

In the BASIS of the BRAIN the veins are not remarkable, nor do they require any description distinct from the sinuses into which they open.

They are small, having little way to run; and before they become large trunks, they empty themselves into the numerous lesser sinuses betwixt the dura mater and the base of the skull. This is perhaps a provision against the pressure of the brain. In passing into those sinuses, the veins take a long oblique course betwixt the lamellæ of the dura mater; which has given occasion to anatomists to describe many intricate lesser sinuses.

## OF THE PARTICULAR SINUSES.




(*a*) The great longitudinal sinus; (*b*) superficial veins; (*c*) the

inferior longitudinul sinus; (*d*) the vena Galeni; (*e*) the fourth sinus; (*f*) the right lateral sinus; (*g*) the left lateral sinus; (*h*) the cavernous sinus; (*i*) the circular sinus; (*k*) the petrous sinus; (*l*) the jugular veins.

By the term sinus we are to understand the great veins of the brain, where they are received into the triangular canals of the dura mater.

### SUPERIOR LONGITUDINAL SINUS.

This is a triangular channel running into the falx from the crista galli of the æthmoid bone to the crucial ridge of the occipital bone. It is not constant in its origin. Sometimes it begins from a blind foramen before the crista galli.* Sometimes from the orbital sinus.† In some subjects it begins only opposite to the fontanelle, or even further back, and then at once swells out to a large size.

As the sinus passes backwards it is gradually enlarging for the reception of the veins from the surface of the cerebrum. The course of the sinus corresponding with the form of the skull is a curve answering to the sulcus, which runs in all the length of the cranium, from the æthmoid bone to the crucial ridge of the occipital bone. The angle formed by the splitting of the internal layers of the dura mater, to form this sinus, is strengthened by strong slips of fibres, sometimes called cordæ Willisianæ, which upon the inside of the sinus have the effect of making the canal irregular, so that it has the appearance of cells, into some of which the probe enters, and leads to the veins on the surface of the brain; others are blind, or lead to lesser sinuses, which not unfrequently run parallel for some length to the great sinus: or the probe passes from one of these cells to another.

* Malacarne, Haller, Gautier.

† These sinuses as frequently are continued into the inferior longitudinal sinus, or into the circular or elliptical sinus; they are like azure streaks under the dura mater covering the orbital process.

Sometimes the sinus has no such irregularities, but is straight and smooth through its whole length.*

This sinus has in some rare instances been found of a square shape; its lower surface serving as a roof for another sinus of a triangular form, which, for some way, ran parallel with the great sinus, and which was of course also included in the lamina of the falx — these Malacarne calls SENI SUBALTERNI. Irregular lesser sinuses are by no means uncommon, and they form, sometimes, communications through a great extent of the longitudinal sinus; or again it will be found that the longitudinal sinus deviates considerably in some subjects, from the straight line, taking a curve or circle, generally behind the fontanelle; or it sends off branches, which again unite with it; or it is fairly divided. In all these cases the chords or fasciculi of the dura mater stretch out over the sinuses, and protect them from compression.

Instead of reaching backwards to the crucial line upon the occipital bone, the longitudinal sinus has been found to divide at the beginning of the lambdoidal sutures, and to follow them in a direction towards the petrous bone †, while the lateral sinuses, running in the duplicature of the tentorium, were reduced to a very narrow compass.

From the strength of the connections of the sinuses, and from the languid course of the blood through them, I cannot believe that the sinus has ever suffered the distention which Malacarne says he has observed. I should rather suppose that what he mentions had been natural and congenital enlargements; especially considering that the sinuses, like the other veins of the body, are frequently irregular.

* The internal membrane of the sinus is perfectly smooth, and is continued into the coats of the internal jugular veins; it is of the same nature with the internal coat of the vein.

† Malacarne, part i. 148.

## LATERAL SINUSES, OR THE FIRST AND SECOND OF THE ANCIENTS.

The lateral sinuses are formed by the splitting of the laminæ of the tentorium, as the longitudinal sinus is formed by the falx. They are continuations of the longitudinal or first sinus. From the crucial ridge of the occipital bone they stretch nearly horizontally, going off right and left, following the connections of the tentorium in a direction toward the petrous bone; then they take a curve downwards and forwards, to terminate in the internal jugular vein; passing through the foramen lacerum betwixt the temporal and occipital bones.

Very frequently the one lateral sinus is larger than the other — generally the right is the larger, and sometimes the left is entirely wanting. *

They diverge from the termination of the superior longitudinal sinus at the crucial point of the occipital bone; but sometimes they are irregular, diverging higher, and even passing round in the circle of the posterior part of the cranium, at some distance from the tentorium. †

The right lateral sinus for the most part begins higher than the left. It is generally longer, and may be considered as the continuation of the longitudinal sinus. Nay, in some subjects, the right or left lateral sinus begins from the longitudinal one, while that of the other side is continued from the fourth, and then the lateral sinuses are separated at their origin by a membranous isthmus. If one of the lateral sinuses receives the superior longitudinal one, it will be found to be four times the size of the other. ‡

I have seen a more remarkable variety of the lateral sinuses. The blood which should flow from all those parts of the brain from which the superior and inferior longitudinal sinus, and the vena Galeni, and

* Lieutaud, Anat. Hist. † Malacarne.
‡ See Morgagni Adversaria VI. tab 1. fig. 1.

fourth sinus are derived, instead of passing by the root of the tentorium, forsook these channels, and consequently the lateral sinuses were left diminutive; and the blood took a course in the tract of the posterior occipital sinuses, and after encircling the foramen magnum, they gained their usual outlet. *

The angles of the lateral sinuses are strengthened by membranous fasciculi; betwixt these the veins enter as in the longitudinal sinus; where the sinus descends from the level of the tentorium in the angle formed by the occipital and petrous bones, there are many strong irregular fasciculi of fibres: under this point, being no longer protected from compression, by their triangular shape and the tension of the tentorium, the sinuses are irregular; they are now sunk in the sulci of the bones, and the dura mater its sheath over them.

The great irregular cavity †, in which the extremities of the lateral sinuses lie ‡, and the foramen lacerum have much variety, and their straightness seems to affect the size of the sinus in its whole length. §

### OF THE INFERIOR LONGITUDINAL SINUS.

The inferior longitudinal sinus, or the lesser, or inferior sinus of the falx, runs in that edge of the falx which penetrates betwixt the hemispheres of the cerebrum. It is extremely small towards the fore part of the falx; but, as it passes backwards, it goes on increasing by the accession of veins which come

* There are instances of the lateral sinuses opening into the external jugular vein.

† Lower conceives that the size of the jugular fossa was the effect of the reflux of the blood; and that the greater size of the sinus of the right side was to be traced to the practice of nurses laying their children chiefly on the right side! See also Morgagni Adversaria Anat.

‡ See Willis Anatom. Cereb. Hum. p. 29. and the plate.

§ Some very large veins open into the lateral sinus; they are derived from the posterior lobes of the cerebrum and the cerebellum. These insinuating irregularly betwixt the lamina of the tentorium, and running for some way, have been considered as additional sinuses. See Haller, tom. iv. p. 149.

from the hemispheres, and corpus callosum, and from the falx itself. It is formed betwixt the lamina of the falx. Sometimes it runs in its very edge, but as frequently a little way removed from it; sometimes it is found beginning very far back in the falx. The fore part of it is more like a vein running in the falx than a sinus. It is in general to be seen more superficial, and in every respect like a vein, (there being no provision for preserving it from compression,) upon one side of the falx. It very often takes a waving course upon the falx; while it receives veins which branch in the substance of the falx, and form communications betwixt it and the superior longitudinal sinus. It opens into the straight or internal sinus, called also the fourth, near the edge of the tentorium.

### OF THE INTERNAL, STRAIGHT, OR FOURTH SINUS.*

I would call this the internal sinus, from its situation, but more particulary from its receiving the veins from the internal part of the brain. This sinus is formed chiefly by the vena Galeni; which, coming out from betwixt the corpus callosum and tubercula quadrigemina, enters betwixt the lamina of the middle part of the tentorium, where it is united to the falx; so that by the tension of these two partitions, this sinus is drawn into a triangular form, and is as incompressible as those sinuses which run connected with the bone.

It opens, for the most part, by an oval mouth, formed by strong pillars of fibres into the left lateral sinus, rather than directly in the middle of the communication of the three great sinuses. We shall find this like the other sinuses, suffering considerable variety; or irregular smaller sinuses will often be found running betwixt the lamina of the tentorium.

* Sinus quartus, Perpendicularis. Haller. — The fourth sinus; the two lateral being the first and second, and the longitudinal being the third sinus.

## POSTERIOR OCCIPITAL SINUSES.

These are so called in opposition to some irregular and small sinuses, which run upon the occipital bone before the great foramen. The POSTERIOR OCCIPITAL SINUS lies in the little falx of the cerebellum: it rises upwards, and opens into the common union of the longitudinal and lateral sinuses; it commonly, however, lies rather to the left, and empties itself into the left lateral sinus. It is by no means constant; like the other lesser sinuses, it is subject to great variety; and before it rises into the tentorium, or empties itself into the larger sinuses, it has a communication or emissaria, by which part of the blood may pass into the external veins, through a foramen in the centre of the occipital bone. *

## THE INFERIOR LATERAL SINUSES.

The inferior lateral sinuses are still more rarely to be found than the last, in so much that Vicq d'Azyr says he never has seen them. They run in the lamina, or under the dura mater of the posterior fossa of the base of the skull; that is, the hollow of the occipital bone, which is under the tentorium. They are so irregular that they frequently occur in one side only. They communicate with the posterior part of the foramen lacerum; with the posterior petrous sinus or vertebral veins; or lastly, they occur as an irregular collection of channels running in the several neighbouring sinuosities. †

* Malacarne. — This sinus is sometimes double; or it has two branches encircling the posterior margin of the occipital hole; or, as I have already observed, it takes the office of the great superior lateral sinuses, and empties it into the foramen lacerum; or it communicates with the vertebral veins. See Observations sur un dilatation singulière des sinus occipitaux, Mem. de l'Acad. Roy. Anno 1781, p. 596.

† "Independente dai seni lateralia inferiori ho veduta tra le "robuste lamine e le fibre, dalle quali incomincia crassissimo "l'imbuto vertebrale intorno al maggior folo del cranio una quan- "tita di caverne, di cellule communicanti insieme, le quali forma-

We see, then, that there is a point of union for all these sinuses, which we have not as yet described: we see that the superior longitudinal sinus, the two lateral sinuses, the fourth (and consequently the inferior longitudinal sinus), and the posterior occipital sinus, unite at the crucial spine of the occipital bone. This is the TORCULAR HIEROPHILI *, TORCULAR, LACUNA, PLATEA, TERTIA VENA, PALMENTUM, PELVIS, LAGUNCULA. It was natural that the attention of the ancients should be drawn to this part; for, upon opening this union of the sinuses, we find a large irregular cavity, which seems to be particularly strengthened by these strong fasciculi of fibres, which indeed are the support of the sinuses.† Ignorant of the circulation, imagining that the blood ascended by the great jugular veins to the lateral sinus, and seeing that the lateral sinuses opened into this central cavity, they conceived that the blood destined for the brain underwent an operation there, and was thence sent through every part of the brain.‡

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" vano un seno circolare irregolarissimo appoggiato sulla parte " superiore, o sia sul margine interno del foro medissimo." Malacarne, p. 113, 114.

Hierophilus was a Greek physician, a disciple of Praxagoras, and cotemporary with Erasistratus.

† " Deinde et alia per sectionem scalpellum injiciens, sursum " adigere conaberis ad usque verticem ubi venæ duæ invicem con- " grediuntur; quam regionem Herophilus nominat lenon, torcular. " Galen." Lib. Nonus de Cerebri, &c. Dissectione.

‡ " Coeuntes autem in vertice capitis, quæ sanguinem deducunt " meningis duplicaturæ, in locum quendam vacuum quasi cister- " nam (quem sane ob id ipsum Herophilus torcular solet nomin- " are,) inde velut ab arce quadam omnibus subjectis partibus rivos " mittunt; quorum numerum nemo facile dixerit, quod partium " nutriendarum numerus sit infinitus. Manant autem rivorum non- " nulli quidem ex medio ipso loco in totum cerebellum, secti, ac " derivati, eodem prorsus modo, quo ii qui in areolis, alii autem ex " parte anteriore feruntur, ea scilicet qua torcular excipit dixeris " utique velut rivum quendam sanguinis, quem et ipsum ex crassa " meninge admodum ingeniose fabricata est, partibus enim ipsius " meningis quæ sanguinem duxerunt ad torcular appulsis, dimissa- " que illinc aliqua in partes subjectas, non amplius, quod super-

## OF THE LESSER SINUSES IN THE BASE OF THE SKULL.

Besides those larger sinuses which we have described, and which convey back the great proportion of blood circulating in the brain, there is a set of lesser sinuses which lurk betwixt the dura mater and the anterior part of the base of the skull. These last are fully more intricate than the others; they lie upon the irregular surface of the sphenoid, temporal, and occipital bones; and tend backwards to the great embouchoir formed by the irregular hole in the temporal and occipital bones.

### THE SPHENOIDAL SINUSES.

The SUPERIOR SPHENOIDAL SINUSES are seated in a fold of the dura mater, on the internal margin of the wing of Ingrassias, and before the great wing of the sphenoid bone; they receive the blood in part from the orbit and from the dura mater; they open into the cavernous sinus, or perhaps into the ophthalmic sinus, which of course, for the most part, conveys the blood into the superior or inferior longitudinal sinus.

The INFERIOR SPHENOIDAL SINUS is very irregular and inconstant. It is in the dura mater, covering the great wing of the sphenoidal bone: the blood of this sinus is emptied into the cavernous sinus, or escapes by emissariæ into the trunk of the temporal veins.

The CLYNOID SINUS.—The posterior clynoid sinus, or elliptic sinus, and the circular sinus, are one and the same; the difference consists only in the manner of describing them; the CIRCULAR SINUS lies within

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" arat, uni venæ concredidit, sed præterea ex crassæ meningis par-
" tibus anterioribus extensis rivulum efficit, ex quo primum multos
" rivulos per totam viam produxit." Galen, cap. vi. *de torcular. Et quo pacto venæ intra cerebrum distribuantur.*

the clynoid processes of the sphenoid bone, and surrounds the glandula pituitaria.*

As this circular sinus opens upon each side into the cavernous sinus, it is not unaptly divided into two; the anterior half of the circle, being the anterior clynoid sinus of some authors; the posterior half (which is in general wider), the elliptical or posterior clynoid sinus, or semilunar.

This sinus, like most of the lesser sinuses, is irregular in its shape, its size, its communications, and its origin.† Its natural communication is with the cavernous sinus, which in fact encroaches upon its side; it will be found to communicate also with the sphenoidal sinuses, and the oblique or petrous sinuses ‡: at one time the anterior half of the circle is wanting; at another the posterior.

### THE CAVERNOUS SINUS.

The cavernous sinus is a great irregular centre of communication with the lesser sinuses in the base of the skull. This sinus is sunk upon each side of the sella turcica, and is formed in the irregular splitting of the lamellæ of the dura mater: it is of a triangular shape; it extends from the sides of the sella turcica, to the foramen spinale. The pointed extremity of the tentorium, which extends forwards from the angle of the petrous bone to the posterior clynoid process, covers and protects it. The cavernous sinus is different from all the others; it is irregular, having fibrous cords traversing it, which give it a kind of

* Ridley describes it in these words: "Another I discovered "by having injected the veins with wax, running round the *pitui*-"*tary gland*, on its upper side, forwardly within the duplicature "of the dura mater, backwardly between the dura mater and pia "mater, there somewhat loosely stretched over the subjacent "gland itself, and laterally in a sort of canal made up of the "dura mater above, and the carotid artery on each outside of the "gland, which, by being fastened to the dura mater, above and "below, at the basis of the skull, leaves only a little interstice be-"twixt itself and the gland."—Brunnerus describes this sinus.

† Malacarne, p. 123.

‡ Haller, tom. iv. p. 154.

cellular appearance. It is like a diseased part into which the blood had been driven, till the cellular texture had been distended and partly destroyed. After a minute injection, small arteries are seen to ramify among these fibres; the internal carotid artery rises through it, and the sixth pair of nerves is involved in it, in their passage from the skull.

This sinus is the centre of the little sinuses and veins of the anterior part of the base of the brain and cranium: four or five veins pour their blood into it, from the anterior lobes of the brain and the fossa Silvii; sometimes, even the opthalmic veins open into this receptacle. * The superior and inferior petrous sinuses, and the basilar sinus, open into it behind; the circular before; the sphenoidal sinuses and veins of the dura mater upon the side; while the right and left sinuses often communicate by means of the transverse sinus. Besides these, the petrous sinuses have several communications, or emissariæ as they are called, viz. into the orbit, by the funnel of the carotid artery, through which descends a vein (the vena sodalis arteriæ carotidis), which terminates in the pterygoid plexus of veins; again veins pass out by the sphenoidal fissure.

The TRANSVERSE, or POSTERIOR CLYNOID SINUS, runs across from one lateral basilar sinus to another behind the posterior clynoid processes. † In its form it is not peculiar, nor is it very regular.

PETROUS SINUSES. — These are three small sinuses which may be called petrous, from lying betwixt the dura mater and petrous bone: one runs near the angle formed by the pars squamosa and pars petrosa

* This vein, the vena angolana, makes a very remarkable emissaria, but it is more probable that the blood in such veins runs inwards than that it escapes from the skull to the external veins. — Cum venis posterioribus frequentes nexus init. Soemmerring, vol. v. p. 354.

† The superior and inferior, or oblique sinus, the cavernous and the transverse, meet nearly at a point.

of the temporal bone; another occupies the groove on the salient angle of the bone; and the third is rather belonging to the cuneiform process of the occipital bone.

The ANTERIOR PETROUS SINUS runs upon the anterior face of the petrous bone: from near the spinal hole *; whence making a semicircular curve in the angle of the petrous and squamous portions of the temporal bone, it terminates in the lateral sinus.

The POSTERIOR PETROUS SINUS † lies in that pointed extremity of the tentorium, which stretches forward, connected with the acute angle of the petrous bone. It is narrow; and a sulcus or groove on the angle of the bone gives a partial lodgment to it; it passes from the cavernous sinus to the great lateral sinus.

The LATERAL BASILAR SINUS, OR INFERIOR PETROUS SINUS, is shorter and larger than the last; and it makes an oblique curve from the cavernous sinus under the pointed extremity of the tentorium, which is continued by the side of the sella turcica, to the termination of the lateral sinus, or rather into the beginning of the jugular vein by a channel, separated by a bony lamina from the termination of the lateral sinus; or it is continued into a vein in the base of the cranium, which afterwards joins the great jugular vein.

The MIDDLE BASILAR SINUS.—This scarcely deserves the name of sinus. It consists, in general, of a few cellular-like communications, formed in strong fibres of the dura mater, which here partakes of the nature of a ligament. These open into the last-mentioned sinus, or sometimes into the vertebral vein.

The VERTEBRAL SINUSES are veins included in the lamellæ of the dura mater; and, divided into right and left, they descend into the tube of the vertebræ,

* And here it has a transverse branch of communication with the cavernous sinus, which runs under the extended point of the tentorium.

† Or superior petrous sinus. Vicq d'Azyr.

on its fore part, and pass down even to the sacrum. They are connected in all their length with the vertebral, dorsal, and lumbar veins. These sinuses or veins, at each vertebra, are joined by a transverse branch; they are connected at the top of the spine with the basilar or anterior occipital sinuses.

### EMISSARIÆ SANTORINI.

"Venæ emissariæ" is but another term for those lesser veins which form communications between the sinuses within the head, and the external veins in the base of the cranium. These, then, are chiefly the ophthalmic *, mastoidean, and vertebral veins. But the vena sodalis arteriæ carotidis, the small vein which penetrates the parietal bone by the side of the sagittal suture, even the venæ arteriæ meningeæ sodales, and the little veins which pass with some of the nerves, or through the fissures of the bone, are also brought into account. To these a much greater importance has been attached than they merit; particularly in apoplectic affections of the head, they have been supposed to be eminently useful in emptying the surcharged sinuses and veins of the brain into the external veins.

But those lesser passages for the blood, supposing us to be assured that the blood flowed through them, from the sinus to the external veins, are insignificant, when compared with the great outlet of the internal jugular vein; to which we have seen all the sinuses tend. But the accumulation of blood in the vessels of the brain is seldom mechanically produced: it is a diseased action of the system of the brain, to which we become more and more liable as we advance in years: and perhaps it is owing to the same

* "Je me suis convaincu, par des dissections multipliées, que "les sinus caverneux et orbitaires communiquent, par un plus "grand nombre de veinules, avec les arrières-narines, de sorte que "les hémorrhages critiques qui se font par le nez, dans les fièvres "aiguës ou la tête est affectée, s'expliquent facilement par ce "moyen," &c. Vicq d'Azyr, Acad. Royale, 1781, p. 504.

gradual change which is operating on the venous system from infancy to old age.

The importance of the sinuses in the circulation of the blood in the brain, does not appear to be perfectly understood, at least judging from the expressions of authors. We find it said, that the sinuses support the blood against compression, and protect its free circulation. This may be one use of the structure which is peculiar to these veins, but surely not the principal one.

Another conception of the use of the sinuses is nearer the truth; viz. to prevent the sudden and violent action of the muscles of respiration, or of the muscles of the head and neck, from injuring the smaller veins of the brain; that the sinuses prevent that impulse from being communicated to the blood in the small and tender veins of the brain, which might endanger a rupture of them.* Yet this is not exactly the manner in which the sinuses preserve the lesser veins; they do not suffocate nor take off the force of the impulse from the regurgitating blood, so much as they would do if they were, like the trunks of veins in other parts, distensible; because, being incapable of distention, they throw the undulation of the blood (when it is thus checked in its exit,) backwards upon the extremities of the veins. But then the effect is, that no particular vein or trunk receives the shock; all suffer in a lesser degree, and equally, which is their safety. All the veins in the base of the brain, which would be liable to rupture, or distention, from receiving, in their sudden turns, the shock of the blood, are preserved by being inclosed in sinuses, and covered by the strong lamellæ of the dura mater. The lesser vessels again are removed from the shock: its force is spent because it has spread among many branches; and it has become a general impulse upon the brain, which the brain resists, because it is incompressible.

* Monro, Nervous System, p. 4.

That the brain does receive such an impulse, in violent coughing and straining, is sufficiently evident from the rising of its surface seen on these occasions, when it is accidently laid open by fracture, or the trepan. *

We ought not to confound the idea of incompressibility of the brain with that of a solid substance, which would allow no motion in the vessels within the cranium, and would require us to invent some specious means to account for the circulation of the blood in the brain, different from that of the other viscera of the body. Were the brain thus incompressible, or rather solid, so as to prevent a free action of the vessels within the cranium, then, as the blood enters with an evident pulsation, it must necessarily have returned by the veins with a distinct pulsation. We accordingly observe that whenever the surface of the brain is exposed it is seen beating. When pus or blood is forcing its way from under the cranium, we can see that a pulsation is communicated to it, and in the oozing out of blood from the longitudinal sinus, I have perceived the same pulsation. When the blood is sent into the arteries of the brain, by the stroke of the heart, they dilate; and this dilatation the pliability of the brain allows, by throwing a comparative degree of pressure upon the veins. Again, when the arteries (during the dilatation of the heart) are in action, and contract, their blood enters the veins, so as to give to them a degree of dilatation equivalent to their former compression, and which now allows the freedom of contraction in return to the arteries; without any compression, therefore, of

* The older physicians, observing the connection betwixt the motion of respiration and of the brain, conceived that the air was drawn through the nose and cribriform bone into the brain, so as to distend it. Upon this hypothesis followed many wonderful cases.

We have already mentioned the hypothesis which supposed compression and relaxation of the cerebrum and cerebellum alternately, by the action of the falx and tentorium.

the brain into a lesser space, there is an activity allowed in the vessels.

This motion, communicated through the brain, is very little, nor does it affect the function of the brain; as we see, when the skull is laid open by wounds, or when the motion is allowed by the fontanelle not being closed. The circulation of the blood in the brain may be obstructed, or it may be accelerated, and by either of these the function of the brain may be affected*: or too much blood may be accumulated within the cranium; but during this accumulation of the blood there must be a proportional space, freed by the absorption of the brain itself, or the partial accumulation in one part of the vascular system of the brain, must be accompanied by a deficiency in the other.

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## OF THE PARTICULAR NERVES.

### THE FIRST PAIR OF NERVES; OR, OLFACTORY NERVES.

We have described the three roots of this pair of nerves: their triangular form, their bulbous extremities, and their manner of perforating the cribriform plate of the æthmoid bone.

Where the soft and pulpy-like mass of the olfactory nerves perforate the æthmoid bone, the dura mater

* There is much ingenuity wasted on the subject of the circulation of the brain: As the gentle murmuring of a stream, says Lower, lulls to repose, while the mind is disturbed, or the imagination awakened by the din of a cataract, so sleep is induced by the gentle flow of the blood in the brain, or is disturbed when the circulation is accelerated. As the fatigue and rest of the body required a variation in the impetus of the blood, the necessary consequence was a variation in the degree of velocity in the circulation and quantity of blood in the head, and this to Lower is the reason of the vicissitude of wakefulness and sleep. The simple fact of the effect of pressure upon the surface of the brain inducing an oppression of the senses has occasioned all their theories of sleep to turn upon this one idea of pressure on the brain.

involves them, and gives them firm coats. There are two sets of nerves thus formed. First, those which pass through the holes in the cribriform plate, nearest the crista galli, run down upon the septum of the nose, under the Schneiderian membrane, and betwixt it and the periosteum; they become extremely minute as they descend: and they, finally, pass into the soft substance of the membrane. The second class of filaments are those which pass down by the outer set of holes of the æthmoid plate, and which are distributed to the membrane investing the spongy bones. Both of these sets of nerves form a considerable net-work or plexus before they are very minutely distributed. *

Although branches of the ophthalmic, pterygoid, palatine, and sub-orbital nerves pass to the membrane of the nose, they have no power of conveying the impression of odours. These nerves are necessary that the membrane may possess the common sensibility bestowed through the fifth nerve.

Before my discovery that the sensibility of the head and face depended on the fifth nerve, there was much controversy whether or not these additional nerves increased the sensibility of the membrane of the nose to odours. We find that there pass to the other organs of sense subordinate nerves; and we know that a nerve may be modified to much variety of functions; and this is evident from the nerve of taste being a branch of the fifth pair. But it is doubtful how far a nerve may be capable of receiving at one instant various impressions. Far from considering distinct nerves sent to the same organ as affording an argument for these nerves receiving one uniform impression, and conveying one simple sensation, it would seem more rational to infer, that one individual nerve cannot perform two functions, and that two functions are often required in the organs of

* Duverney first observed this course and firmness of the olfactory nerves.

† John Hunter. Animal Economy, p. 265. Munro, tab. xxiv.

sense. The olfactory nerve is incapable of bestowing common sensation on the membrane of the nose; the other nerves which ramify on that membrane, do, on the other hand, contribute nothing to the sense of smell; we find that the inflammation of the pituitary membrane, which raises the sensibility of the branches of the fifth pair of nerves, does in no degree make those of the olfactory nerve more acute. The membrane is painfully inflamed, but the sense of smell is deadened.

### SECOND PAIR; OR, OPTIC NERVES.

In this part of the work there is no occasion to deliver any thing further concerning the optic nerves, than has been already said of their origin, and final expansion in the retina of the eye. They are uniform in their shape and course, and give off no branches, implying that they are appropriate to a distinct office from the other nerves.

### THIRD PAIR OF NERVES; OR, MOTORES OCULORUM.

These nerves have the name of motores oculorum, because they are distributed to the muscles which move the eye-balls. They pass upwards from their origin; and then diverging, they penetrate the dura mater under the extreme point of the tentorium; they descend again by the side of the cavernous sinus, and pass out of the cranium by the foramen lacerum of the sphenoid bone. When this nerve has entered the orbit by the foramen lacerum, it gives out at the lower and outer part of the optic nerve, a lesser SUPERIOR branch which crosses the optic nerve to supply the superior rectus muscle of the eye, and from which a branch, having perforated that muscle, goes to the levator palpebræ. The trunk of the *third* continues its course under the optic nerve, and nearly at the same place it sends out three branches lying close together. 1. To the inferior rectus, or depressor oculi. 2. To the inferior oblique muscle. 3. And to the internal rectus. Or sometimes, varying somewhat, it gives off the first branch to the internal rec-

tus or adductor, another large branch to the depressor, and the continued trunk terminates in the inferior oblique muscle. In tracing the branch which goes to the inferior oblique, we come upon a division of this nerve, which forms the principal root of the ophthalmic, or ciliary, or lenticular ganglion. Haller is of opinion that the ganglion is formed by the third nerve alone, but there is no doubt that a branch of the fifth, viz. of the nasal branch of the ophthalmic division, enters into its composition.

Besides the small ciliary nerves coming from the ganglion, other delicate nerves, both from the third and fifth, pierce the sclerotic coat of the eye. We may more especially notice a twig from the nasal branch of the fifth which goes to the inner part of the eye.

### FOURTH PAIR OF NERVES; TROCHLEARES, OR PATHETICI.

These nerves are very small. Their origin, from the superior part of the spinal marrow, and their long course under the base of the brain, have been already described; after proceeding a considerable way, incased in the duplicature of the dura mater, where it forms the extreme point of the tentorium, they pass amongst the lamellæ of the dura mater, where it forms the cavernous sinus. They pass by the outside of the third pair of nerves; turn round so as to be above them, and make their egress through the foramen lacerum of the sphenoid bone. They pass forward in the orbit, undiminished by the giving off of branches; and are each finally distributed to the superior oblique muscle or trochlearis. Sometimes, however, in their course over the cavernous sinus to the orbit, they send branches to unite with the ophthalmic division of the fifth pair; but this is by some anatomists described as only a close adhesion to the dura mater. My pupils have traced these connections betwixt the fourth and fifth nerves.

* Soemmerring. Winslow. Miekel.

In the part of these volumes which treats of the motions of the eye-ball, a reason will be assigned why the origin of the fourth nerve is near the portio dura of the seventh pair, and consequently remote from that of the third.

### THE FIFTH PAIR; OR, TRIGEMINI, OR, GRAND SENSITIVE NERVE OF THE HEAD.

The tracing of the branches of the fifth pair, by dissection, is a difficult task; for those branches are distributed among the bones of the face, to the eyes, nose, mouth, tongue, and throat. From this extensive distribution, the fifth nerve is necessarily the largest of those that pass out of the cranium.

It is of a flattened form *; it penetrates the dura mater at the anterior point of the petrous bone, and spreads flat under it. Here, under the dura mater, it is matted into one irregular ganglion; viz. the semilunar, or Gasserian ganglion. This ganglion lies on the anterior point of the temporal, and on the sphenoidal bone. In their passage from the brain, the filaments composing the fifth nerve are loose, or easily separated; at this place, they are found so subdivided and entangled as to resist further division. The nerve here swells out into a greater size; it seems to be incorporated with the dense fibres of the dura mater; it becomes of a dark red, or mixed colour, having a semilunar mass of matter of the same appearance as ganglion, stretching across it; all which circumstances have, by no means, been unobserved by anatomists. Vieussens supposed, that the use of this ganglion of the fifth pair, before it perforates the cranium, was to strengthen the nerve, and enable it to withstand the motion of the jaws! Others have said it was a ganglion connecting in sympathy all those parts to which the nerve is finally

* So it is said, by Meckel, to resemble the flat worm, or tenia.

distributed; and that it was the source of the sympathy which we observe among the muscles of the face.*

The connection of the Gasserian ganglion with the dura mater, is so firm, that it yet remains undecided, whether there are sent off here any nerves to that membrane; but I conceive that there are none, and that the connection of the ganglion with the fibrous membrane, or sheath which covers it, has been mistaken for nerves passing from the ganglion to the dura mater.

From the semilunar or Gasserian ganglion, the fifth nerve divides into three great branches; whence the name of trigeminus:

1st, The OPHTHALMIC BRANCH of WILLIS, which passes through the foramen lacerum into the orbit.

2d, The SUPERIOR MAXILLARY NERVE, which passes through the foramen rotundum.

3d, The INFERIOR MAXILLARY NERVE, which passes to the lower jaw, through the foramen ovale.

Such was the description of this nerve, until I found a necessity of examining it more minutely. I then found that Soemmerring, and others, had observed, that this nerve had two roots, and that one of these roots did not go into the ganglion. Afterwards, upon comparing it with the spinal nerves, I found its correct correspondence to them; and, as I have stated in the introductory view, that it was the superior spinal nerve, corresponding in function and bestowing upon the head the powers of sensibility and motion, which were given to the body through the spinal nerves.

The ophthalmic and superior maxillary nerves go off from the ganglion of this nerve, and so does a part of the third division. The root or fasciculus, which passes the Gasserian ganglion, joins the third

* "Et affectum animi indicia in faciei partibus depingere adjuvet." Hirsch. Sand. Thes. Diserta. p. 491.

division, and goes out with it through the foramen ovale. *

### THE OPHTHALMIC BRANCH OF THE FIFTH PAIR.

This nerve enters the orbit in three divisions; these are, the *frontal*, the *nasal*, and the *lachrymal* nerves. Before its division, the trunk of this nerve communicates by a small branch with the third nerve. †

1st, The first of these runs under the periosteum of the upper part of the orbit, and above the levator palpebræ superioris. Upon entering the orbit it gives off a small branch, which passes to the frontal sinus; the nerve then divides into the super-trochlearis, and the proper frontal nerve. The first of these passes to the inner part of the orbicularis oculi and frontal muscle. The other, the outermost, and the proper frontal nerve, passes through the hole, or notch, in the margin of the orbit, and mounts upon the muscles and integuments of the forehead. These superficial branches communicate with the extreme branches of the portio dura, or nervus communicans faciei; a circumstance which we have proved to be

* Ope horum vasorum communis nervi truncus in duo fasciculorum strata separabatur anterius nempe et posterius. Posteriori nunc strato parva portio adhærebat, perpendiculariter in caveam descendebat et absque omni cum intumescentiâ semilunari facta commistione in ramum tertium seu maxillarem inferiorem inserebatur. Wrisberg. tom. i. p. 267. Ludwig.

Wrisberg has also a drawing which shows the two roots forming the 5th pair; he distinguishes them thus: P. s. portio ejusdem, (Quinti Paris,) superior et anterior; p. i. portio inferior posterior major.

Soemmerring makes particular mention of the distinction of the two roots forming the fifth pair. " Summe autem memorabile videtur secundam vel minorem quinti portionem omnino non immisceri subrubello plexui gangliformi, in quem portio major dissolvitur, sed fere integram ad ramum tertium abire. [1]

† See Meckel's Disertation on the fifth pair.

[1] Primus et solus hoc in tabulis expressit celeb. Prochaska libro; sec. 3. citato tab. 2. fig. 4, 5, 6. Soemmerring de Basi Encephali, etc., sec. lxi. tom. ii. Ludwig.

of the highest interest, since the division of the branches of the fifth deprive the parts of sensibility; whilst the division of the branches of the portio dura deprive the muscles of motion.

Cases are on record, of wounds of the frontal nerve occasioning a great variety of nervous symptoms, and especially loss of sight; and it certainly marks a very particular connection and sympathy betwixt this branch and the common nerves which pass to the eye-ball and iris, and the retina, that blindness is actually occasioned by the pricking of the frontal nerve. Morgagni supposes this to be occasioned by the spasmodic action of the recti muscles pressing the globe of the eye down against the optic nerve.

2d, The NASAL BRANCH of the ophthalmic nerve sends off a slip or twig to form with a branch of the third pair, the LENTICULAR, or, OPHTHALMIC GANGLION*; while the trunk of the nerve passes obliquely forwards, under the atollens palpebræ, and levator oculi, it gives some filaments to these muscles. While pursuing its course along the inside of the optic nerve, it gives off one or two extremely small twigs, which join the fasciculi of ciliary nerves coming off from the ganglion. The nasal branch then continues its course betwixt the superior oblique and adductor muscles; before piercing the orbital plate, it sends forward a branch, which, passing under the pulley of the superior oblique muscle, joins that division of the frontal nerve which passes over the pulley. This branch supplies the caruncula lachrymalis, and sends a twig down to the lachrymal sac and duct. It emerges from the orbit superficial to the tendon of the orbicularis oculi, and unites with the branches of the portio dura, and of the infra-orbital branch of the fifth. The proper nasal nerve passes through

* Vieussens describes delicate twigs which are distributed on the inferior rectus and the abducens muscles before this lenticular branch is given off. *Fig.* xxii. *let. g. h. i. i.*

the foramen orbitarium anterius, enters the skull again, and lies on the cribriform plate of the æthmoid bone under the dura mater. It passes through one of the anterior holes of the cribriform plate, and gives branches to the frontal sinuses. After having continued its course in a groove on the nasal process of the frontal bone, it runs forward and downward in a similar groove on the inside of the os nasi ; from thence, getting on the outside of the cavity of the nose, it runs along the cartilaginous part of the ala, and near the extremity of the nose mounts upon the tip of the ala, and then, dipping down between the two alæ, is lost on the anterior extremity of the cartilaginous septum. In its course it sends several small filaments into the alæ. It bestows common sensibility to the membrane of the nose, while the sensibility to odours belongs to the first nerve.*

We observe such a connection of the nerves of the eye and nose, and of those distributed to the inner angle of the eye, and muscles of the eye-lids, as sufficiently accounts for the sympathy existing among those parts. We see the necessity of this connection, since the excitement of the glands which secrete the tears, the action of the muscles, and the absorption of the tears into the nose, must constitute one action ; nevertheless this motion of the muscles, when the surfaces are excited, results from the connection of the nerves (the fifth and seventh,) in the brain, as might be easily shown. Willis describes a nerve going off from the nasal branch to the retractor oculi in brutes.

The LENTICULAR, or, OPHTHALMIC GANGLION, comes again to be considered under this division of the fifth pair. It is formed by a twig from the nasal branch of the fifth pair, and a division of the third pair of nerves. The ganglion is of a square form, and is situated upon the outside of the optic nerve. The ciliary nerves pass out from this ganglion in two

* See John Hunter, Animal Economy. Munro, tab. xxiv.

fasciculi; they are ten or twelve in number; they are joined by branches of the continued nasal nerve. The ciliary nerves run forward amongst the fat of the orbit, to the sclerotic coat of the eye, and pierce it very obliquely in conjunction with the ciliary arteries. The ciliary nerves and arteries then pass forward betwixt the sclerotic and choroid coats of the eye to the iris. The iris is considered as the part the most plentifully supplied with nerves (as it certainly is also with arteries) of any part in the body. It follows, indeed, from what we formerly said, that a profuse circulation of blood is necessary to an accumulated nervous power. The fine sensibility and mobility enjoyed by the iris is owing to those nerves: the fifth nerve giving sensibility, and the third mobility.

From the connection of these ciliary nerves with those passing to the nose, Soemmerring accounts for sneezing being the consequence of a strong light upon the eye. This may perhaps be true; but, certainly, the temporary loss of sight, from sneezing, does not depend upon this connection of the nerves, but upon the immediate affection of the optic nerve and retina, from the concussion and interruption to the circulation, or from the accumulation of blood in the eye.

2. The LACHRYMAL NERVE is the least of the three divisions of the ophthalmic nerve; it divides into several branches before and after it has entered the gland.* Several of these branches pass on to the tunica conjunctiva, being joined by a twig of the first branch of the superior maxillary nerve. Others connect themselves with the extremities of the portio dura of the seventh pair, and with the superior maxillary nerves. By these the flow of the tears is com-

* Vieussens, Haller and Meckel take notice of small delicate nerves which are the continúation of the nerves of the lacrymal gland, and can be traced to the tunica adnata. Although they observe some anatomists have considered these to be the ducts of the lacrymal gland.

manded by the degree of irritation of the surface of the eye, so that the tears flowing, wash away the offending matter. I have had several cases communicated to me of total insensibility of the surface of the eye, while the motion and sensibility to light remained entire. In all these instances I had reason to attribute the defect to the injury of the fifth nerve.

### THE SECOND BRANCH OF THE FIFTH PAIR; VIZ. THE SUPERIOR MAXILLARY NERVE. *

The superior maxillary nerve, the middle one of the three divisions of the fifth, having passed the foramen rotundum, emerges behind the antrum Highmorianum, at the back part of the orbit, and near the root of the pterygoid process of the sphenoid bone. The infra-orbital canal lies directly opposite, and ready to receive one branch, while the spheno-maxillary opening is ready to receive another. Here several small branches go off, the *Rami molles medullares*, and render the dissection difficult. † The chief part or trunk, of the nerve may be said to be seated, and to give out its divisions in the pterygo-palatine fossa. Through the spheno-maxillary fissure, a branch of the superior nerve is sent into the socket of the eye. This twig unites with branches of the lachrymal nerve, and in general supplies the periosteum of the orbit. It then sends, through the foramen in the os malæ, a branch which is distributed to the orbicularis muscle of the eye-lid, and to the skin of the cheek, viz. *subcutaneus malæ*. Another branch of this division passes upward from the zygomatic fossa, in a groove of the wing of the sphenoid bone, to the temporal muscle, and getting superficial, it accompanies the branches of the temporal artery. Here it becomes superficial, forming the *subcutaneus temporalis*.

The superior maxillary nerve, after sending off these branches, divides into four branches: 1. *Vidianus*.

* According to Winslow.

† Meckel de 5to pare. lviii.

2. *Palatinus.* 3. *Alveolaris*; whilst the continued nerve is, 4. *Infra-orbitalis.*

The VIDIAN nerve sends off branches which enter the nares, and extend betwixt the mucous membrane and periosteum to the ethmoid and spongy bones. These are divided into the *nasales superiores anteriores et posteriores.* Where the Vidian nerve parts from the trunk, the *spheno palatine ganglion* is formed *, and having sent these nasal branches off, it enters the foramen pterygoideum and runs backwards. Here it splits; one branch, after a long retrograde course, enters the Vidian hole of the petrous part of the temporal bone, and forms a connection with the portio dura †, while the other, in the carotid canal, forms a connection with the great sympathetic nerve, by joining the branches of the fifth and sixth pair, which pass down with the carotid artery. In the manner of joining of the sixth, the Vidian and the sympathetic in the carotid canal, and around the carotid artery, a considerable variety occurs. It is, in fact, a union of the fifth, sixth, and seventh with the ascending visceral nerve.

The *superior posterior* nerves of the nose come off from the Vidian just when it has entered within its canal.

The PALATINE nerve is the largest of the branches sent out from the spheno-palatine ganglion. Before it descends it gives off small nerves called *anterior superior internal,* which ascend to the superior spongy bone, and join with the posterior branches of the olfactory nerves.

The palatine nerve next gives off the *naso-palatine* described by John Hunter and Scarpa. This nerve

* Meckel de Ganglio Secundi Rami Quinti Paris nuper detecto Histoire de l'Acad. Roy. des Sciences, Année 1749, à Berlin 1751, p. 84.

† In the fœtus, the foramen innominatum or vidian hole is so short, that the union of the vidian nerve and portio dura may be seen. In the adult it is seldom necessary to cut more than the tenth of an inch to expose clearly the union of the nerves. See John Hunter. Animal Economy, p. 266.

bending upon the superior part of the vomer, and coursing in an oblique manner towards the anterior and lower part of the vomer, pierces the foramen incisivum, and is lost in the gum, behind the incisor tooth, and on the membrane of the roof of the mouth at that part.

We have to recollect that there are two canals in the palatine bone, conveying nerves to the palate: one the anterior and larger, another running nearly parallel to it, which is smaller. The division of the palatine nerve, descending at first along the spheno-palatine canal, which leads to the palatine foramen, gives off the *inferior internal* nerves of the nose, which are distributed principally on the upper and lower turbinated bones. Continuing its course along the canal, it sends off a branch to the tonsils, which descends before the pterygoid processes and betwixt the maxillary and palatine bones, and is called the *palatinus minimus exterior*. A small nerve descends through that foramen, which is immediately anterior to the pterygoid process, to supply the circumflexus, levator palati, and azygos uvulæ. * While the larger branch descends through the greater and more anterior foramen, and divides into three branches, which supply the soft parts lining the palatine bone, and the palatine plate of the maxillary bone; also the arches of the palate. A groove in the bone points out the course of this nerve forwards.

The SUPERIOR MAXILLARY NERVE, after sending off the branches which form the spheno-palatine ganglion, passes obliquely downward to the infra-orbital canal. In this course it gives off the posterior nerve to the teeth of the upper jaw; and this again gives off a twig, which takes a course on the outside of the maxillary bone, and supplies the gums and alveoli, and buccinator muscle.

Before entering the canal it sends off the ALVEOLAR branch, which supplies the molares, through the fora-

* I am of opinion that these muscular nerves may in part be ramifications of the portio dura, coming along the videan foramen.

mina, on the posterior surface of the maxillary bone, and then follow the alveolar branches of the internal maxillary artery; a branch from this division enters the buccinator muscle.

While passing in its canal, the INFRA-ORBITAL nerve gives off the anterior nerves to the teeth; and when it emerges from the infra-orbital foramen, it spreads widely, and forming a plexus, enters the muscles of the lip and nose, goes on to the integuments; and here it is of course joined by the appropriate division of the portio dura, connecting itself with the extremities of the portio dura of the seventh pair or nervus communicans facialis.

The "tic doloureux," and the "tic convulsif," of the French authors, are diseases attributed to the affection of this nerve. The seat of the tic doloureux is the side of the face, the nostril, the cheek-bone, and root of the alveoli. Sauvage calls it the trismus dolorificus, or maxillaris. But it is a disease not absolutely fixed to this point of the cheek-bone; but on the contrary, from the universal connection betwixt the nerves of the face, it takes, sometimes, a wide range; however I attribute it to the influence of the sympathetic nerve, and conceive that this is the reason that the disease is so often seated in this superior maxillary nerve, which has the most direct connections with the sympathetic.

It is a disease attended with extreme pain, which forces the patient to cry out in great agony. The patient has described it to me as like a flash of lightning through the head, so sudden is it in its attack. And as to its violence, it is sufficient to say, that it throws the same patient into the most violent contortions of pain, who will sit unmoved and suffer the nerve to be deliberately cut across. The pain is felt deep rooted in the bones of the face, and seems to spread upon the expanding extremities of the nerve; it is sudden, violent, and reiterated in its attack, and it varies in the length and repetition of its accession.

This disease is apt to be confounded with the

affection of the antrum Highmorianum, the tooth-ach, rheumatism, and clavis hystericus, or even with venereal pains.

In hemicrania, the affection of the three branches of the fifth nerve, is such as to mark their distributions. There is swelling and pain of the face, pain in the upper maxillary bone, pains in the ear and in the teeth, difficulty of swallowing, and lastly, stiffness in moving the lower jaw, in consequence of the affection of those branches which pass up to the temporal muscle.

There are cases spoken of by Sabbatier, where this infra-orbital nerve being wounded, unusual nervous affections, and even death, were the consequence: but it would rather appear, that, independently, altogether of the affection of the nerves of the face, inflammation spreading from the wound to the brain, had, in the examples which he gives, been the occasion of the unusual symptoms, and of the death of the patients.

## THIRD BRANCH OF THE FIFTH PAIR: OR, LOWER MAXILLARY NERVE.

This, the last of the three great divisions of the fifth pair of nerves, the largest but the shortest branch within the skull, passes out by the foramen ovale. * It is distributed to the muscles of the lower jaw, tongue, the glands, and skin.

On instituting the comparison betwixt the spinal nerves and the fifth, I observed that a fasciculus passed the Gasserean ganglion and joined the third division, and passed with it through the foramen ovale. Having followed it thus far, I put my pupils on the further prosecution of this branch to determine whether the peculiarity of this division was owing to its being the gustatory, or a muscular branch. I could, upon their authority, show that this was the motor portion of the fifth nerve, and that

* The lower maxillary nerve of Winslow, gustatory of Meckel. Ramus major posterior nervi quinti paris, Vieussenii.

it went to the muscles of the jaw and cheek. But at the same time I consulted books, and I found the most perfect description of the nerve, and so entirely unbiassed by a mere dissector, that I shall prefer stating what Palletta affirms.*

Having observed this free division of the fifth nerve, he chooses to consider it as a newly discovered nerve; traces it from its origin along the inside of the proper fifth, and past the ganglion, and into the foramen ovale. While they are passing together through the bone, a few filaments from that portion of the nerve which has a ganglion, unite with the nerves proceeding from this newly-discovered trunk. I may just observe that if we were to admit this to be a new nerve, we might so distinguish the anterior roots of all the spinal nerves, since this division is to the fifth what the anterior division is to the proper spinal nerves. Observing this (anterior) division of the fifth narrowly, he finds it consisting of two nerves: 1. *Fasciculus primus seu nervus crotaphiticus.* 2. *Fasciculus secundus, seu nervus buccinatorius.* Tracing them on their course through the foramen ovale he finds them passing as their names imply, into the temporal and buccinator muscles. The First of these gives off the *nervus massetericus.* The ramus massetericus passing betwixt the external pterygoid and temporal muscles, and over the semi-lunar notch of the lower maxillary bone, and behind the tendon of the temporal muscle, sinks into the masseter. Hence, a branch passes out to the integuments of the cheek, viz. the *nervus temporalis superficialis seu auricularis* which emerges from the parotid gland near the root of the jugum.† This nerve also gives off the two temporal nerves, which are named *temporalis profundus exterior* and *temporalis profundus interior.*‡ The

* J. B. Palletta de nervis Crotaphitico et Buccinatorio, 1784. Mediolani. Ludwig, tom. iii. p. 63.

† Winslow describes this cutaneous branch, joining with the portio dura. Meckel has not observed it.

‡ A branch of the temporalis profundus enters the orbit and joins the lacrymal nerve.

Second of these, or the buccinatorius, supplies the pterygoideus externus, and gives some twigs to the temporal muscle. It then supplies the buccinator muscle, the glandulæ buccales, and a few delicate nerves upon the cheek, unite with the branches of the portio dura. The nervus buccinatorius gives off the ramus pterygoideus, which is a small branch going to the pterygoideus internus, and circumflexus palati. In short, tracing this division of the maxillary nerve, in all its course, he finds it exclusively given to the muscles of the jaw and cheek.* But a circumstance occurs here not without interest: before entering the muscles these branches are joined by branches of the ganglionic portion of the nerve, (which he persists in calling the maxillary nerve, in contradistinction to his supposed discovery of the new nerve.)

When we compare the distribution of the nerves to the muscles of the jaws and cheek, with the distribution of the seventh pair and the fifth pair, to the external muscles of the face, and when we take into consideration that the division of the seventh nerve cuts off all power of moving the muscles of the face, a question may very naturally occur. If dividing the muscular nerves is attended with loss of motion in the muscle, what is the use of the sensitive nerves which

* Meckel, in his description of the third division of the 5th pair, follows Eustachius and Albinus in subdividing this nerve into two distinct sets of branches. When it has passed through the foramen ovale it is divided into two portions, which Albinus distinguishes as the Anterior and Posterior branches. Meckel describes them under the names of Superior and Inferior, the former splitting at once into many separate branches, while the latter is the larger nerve, and forms the continued descending portion of this third division. He enumerates as belonging to the SUPERIOR RAMUS, 1. The Massetericus. 2. Temporalis profundus exterior. 3. Temporalis profundus interior. 4. Buccinatorius. 5. Pterygoideus. The INFERIOR RAMUS, after giving off some small branches to join those of the SUPERIOR, is composed of three principal branches: 1. Maxillaris inferior. 2. Lingualis seu gustatorius. 3. Temporalis superficialis. See Meckel, de quinto pare nervorum. Sect. v. tom. 1. Ludwig.

are given to these same muscles, seeing they confer no power of motion? *

We now attend more particularly to the two greater divisions of this nerve, the proper maxillary nerve which passes into the lower jaw, and the gustatory or lingual nerve, after the nerve has passed the pterygoid muscles.

The GUSTATORY NERVE is the division which descends to the tongue. Immediately after its separation from the nerve of the lower jaw, it is joined by the *chorda tympani;* or, perhaps, we should rather say, a branch of this nerve, by traversing the petrous portion of the temporal bone in a retrograde direction, unites itself with the portio dura of the seventh pair, as it is passing through the ear. This nerve being seen passing across the tympanum is the reason that it is called CHORDA TYMPANI. It is commonly described as going along the Eustachian tube; we ought rather to say in the groove of the bone under that passage. Arriving in the cavity of the tympanum, it runs across and joins the portio dura before its exit by the stylo-mastoid foramen. The gustatory nerve, proceeding obliquely downward, sends off twigs to the salivary glands and muscles, situated betwixt the jaw-bone and tongue. Where it is passing by the side of the sublingual gland, it gives out some filaments which form a small GANGLION, from which branches penetrate the submaxillary and sublingual glands. The trunk then proceeds onward betwixt the sub-lingual gland and the musculus hyo-glossus; several twigs are sent off, which form a kind of plexus amongst the muscles and salivary glands †; and communicating with the ninth pair of nerves, are distributed, finally, to the gums and membrane of the mouth.

The gustatory nerve terminates in a lash of nerves,

* This is the first idea which suggested the paper in the Transactions of the Royal Society entitled "On the Nervous Circle which connects the Voluntary Muscles with the Brain."

† Plexus gangliformis. Scarpa.

which sink deep into the substance of the tongue, betwixt the insertion of the stylo and genio-glossal muscles. These pass to the papillæ on the tip and edges of the tongue. The sense of taste, the impression of which is received upon this nerve, is seated in the edge and anterior part of the tongue.

The proper lower maxillary nerve, which enters into the lower jaw-bone, sometimes called *mandibulo labralis*, passes downward in an oblique direction to the groove of the lower jaw-bone. Before this nerve enters the canal of the bone, it gives off branches to the mylo-hyoideus and digastricus, to the sub-maxillary glands, and to the fat. The nerve then entering the bone, runs its course all the length of the lower jaw within the bone, and comes out at the mental hole. In this course it gives branches which enter the roots of the teeth, and accompany the branches of the arteries. When this lower maxillary nerve has escaped from the mental hole, it divides into two branches upon the chin; one of these is distributed to the orbicularis and depressor anguli oris, and to the skin and glands of the lips; the other to the depressor labii inferioris and integuments, and forms a kind of plexus, which surrounds the lips. These nerves are also connected with the wide spreading branches of the portio dura of the seventh pair; and they are the lowest branches of the facial nerves, and the last enumerated of the intricate branches of the fifth pair.

In recapitulating the branches of the fifth nerve, it is only necessary to say that it goes every where to the head and face, externally and internally; that it is then universally the nerve of common sensibility; that it possesses also some peculiar sensibilities, as on the surface of the eye. Finally, that it is the nerve of the muscles of the jaw. On exciting the root of the fifth pair of an ass recently killed, the jaws were made to snap violently. And on dividing the fifth in another ass, the jaw fell down, the muscles being incapable of closing the jaw. On attempting to

excite the muscles of the eye by galvanism sent through the fifth pair, the muscles of the jaw were affected.

Professor Böch of Leipsic, and M. Cloquet of Paris, in prosecuting the minute anatomy of the sympathetic nerve, have described a small ganglion lying on the carotid artery, where it has just entered within the skull. This my pupils have frequently shown to me, and we find it described by Willis. * From the dissection of those nerves, in the larger animals, it appears quite an error to suppose that the principal connection between the nerves of the head and the sympathetic is through the sixth pair. For this small ganglion is a centre from which nerves can be traced to the ophthalmic division of the fifth, the sixth, and the sympathetic. †

### THE SIXTH PAIR OF NERVES; ABDUCENTES, OR MOTORES EXTERNI.

The sixth pair of nerves, as we have seen, arises betwixt the tuber annulare and the corpus pyramidale. Advancing forwards and upwards, sometimes above and sometimes beneath the branches of the basilar artery, it penetrates the dura mater by the

* Alter superior idemque major Paris quinti ramus, sub dura matre juxta sellæ turcicæ latus aliquanto spatio recta incedit: atque è regione Glandulæ pituit ariæ carotidis trunco propagines quasdam elargitur dein nervo sexti Paris inosculatur: et exinde surculum, modo unum, modo duos remittit, qui cum surculo altero, a nervo sexti Paris reflexo, uniti, nervi intercostalis radicem, sive caudicem primum constituunt. Willisii Opera Omnia, cap. xxii. fig. 1., litt. A. *b. b.*

† It was a subject of very warm discussion amongst Haller's pupils, whether there were any twigs connecting the 5th pair to the sympathetic within the skull.

Meckel in his treatise on the 5th pair, inveighs most vehemently against all persons who pretend that the 5th pair has any connection with the sympathetic, besides that which it has through the Vidian nerve. He appeals to the characters of Eustachius, Haller, Albinus, and Morgagni, to support him in the denial of such branches existing. He affirms that no other nerve than the sixth gives origin to the sympathetic. See Winslow translated by Douglas, pp. 80, 121, vol. ii. for a true description of the connections of these nerves.

side of the basilar sinuses. It then passes by the side of the carotid artery, and through the cavernous sinus. Here it gives off filaments, which, clinging to the carotid artery, descend with it until they are joined by a branch of the Fifth Pair. These together form what was formerly considered the origin of the great sympathetic nerve. It has been disputed whether a branch is given out from, or received into, the sixth nerve; and in the description of the sixth pair, we might say, with reason, that as it passes the carotid artery, it receives one or more nerves which come up through the carotid hole, and encircle the artery. The sixth nerve enters the orbit by the foramen lacerum, with the third and fourth nerves and first branch of the fifth. It pierces the abductor muscle of the eye before it is finally distributed to its substance.

It is with particular pleasure that I have here to refer again to our celebrated countryman, Willis, whose minute knowledge of anatomy cannot be sufficiently admired. He describes a branch of this sixth nerve going to the retractor oculi of brutes. When we consider the office of the retractor oculi to be the protrusion of the *haw*, it suggests to us a reason why the sixth nerve should go to the external rectus: for the direction of that muscle is such, that in its action it must draw the eye-ball towards the os planum, and assist the retractor oculi in thrusting out the haw. If it be said, what then is its use in the human eye? we may allege that it is for the same purpose, that is, to draw the eye when painfully excited towards the os planum, and so thrust out the semilunar fold and caruncula lacrymalis. In matter of fact, the caruncula and membrane are thrust out, however we may explain it; for if the eye-lids be kept forcibly apart, and an attempt be made to wink, as if a mote were in the eye, the membrana semilunaris and caruncula lacrymalis are brought forward over the eye so as to make no bad representation of the haw. It is curious that Soemmerring describes the sixth arising in two roots, an external and an internal portion. Vicq d'Azyr, and Scarpa describe an

external larger and internal smaller portion constituting the roots of this nerve.

It has been presumed that the sixth nerve does not give off the sympathetic nerve, but receives those branches from it, because the sixth nerve is larger betwixt this point and its distribution in the orbit, than betwixt the same point and its origin from the brain. But I conceive, that this enlargement of the sixth pair is not owing to such a junction; but that, on the contrary, the nerve naturally swells out when it enters the sinus, not from being soaked in the blood of the sinus, but from its having additional investing coats, or from the coats being strengthened in order to prepare the nerve for its passage through the sinus.

Again, that the sympathetic nerve sends up those branches to join the sixth, has been presumed from the effects of experiments on brutes in which the sympathetic nerve has been cut or bruised. Inflammation and heaviness of the eye has been observed to result from these experiments.

We shall probably cease to dispute this point, when we consider the relations and use of the sympathetic nerve.

The sympathetic nerve may be defined, a tract of medullary matter, passing through and connecting the head and neck, the viscera of the thorax, abdomen, and pelvis, into one whole. The sympathetic nerve is singular in this, that it takes no particular origin, but has innumerable origins, and a universal connection with the other nerves through all the trunk of the body. Many of the viscera to which it is distributed are entirely independent of the will, and have functions to perform too essential to life to be left under the influence of the will. The sympathetic nerve is thus, as it were, a system within itself, having operations to perform of which the mind is not conscious; whilst the extent of its connections occasion, both in health and disease, sympathetic affections not easily traced.

It is impossible seriously to consider the sixth nerve as giving the origin to the sympathetic in any other light, than as such an expression may be subservient to arrangement, description, and general enumeration of the nerves;—a thing most necessary in so intricate a piece of anatomy. The character of the sympathetic nerve (or, I believe I should say, sympathetic system of nerves,) is that of having ganglions formed upon it;—and thus the ganglions in the sockets of the eyes, in the fossæ of the jaws, and every where, whether within or without the head, are to me proofs of the sympathetic nerve extending its connections to such parts.

### OF THE SEVENTH PAIR OF NERVES.

The nerves of the seventh pair consist each of two fasciculi which arise together, and pass into the foramen auditorium internum. * But these portions do not pass through the bone in union; for the anterior and lesser fasciculus, is a muscular nerve, which passes through to the face, and is invested, like the common nerves of the body, with strong coats. It is therefore called the PORTIO DURA. † The more posterior fasciculus is the auditory nerve, and is distributed to the organ within the pars petrosa of the temporal bone; and in distinction it is called the PORTIO MOLLIS.

The PORTIO DURA, OR NERVUS COMMUNICANS FACIALIS, OR RESPIRATORY NERVE OF THE FACE. This is the grand motor and respiratory nerve of the face. When divided all motions but those of the jaws cease, and more especially all consent of the muscles of the face with the actions of respiration are cut off by the loss of this nerve. The portio dura in passing from the brain to the internal auditory foramen, is lodged

* The intermediate filaments of Wrisberg, which are betwixt these two portions of the seventh nerve, is afterwards united to the portio dura, and must be considered as one of its roots.

† Galen divided all the nerves of the brain into those two classes *mollis* and *dura*; of which the first were those of the senses, the latter the motores corporis.

in the fore part of the auditory nerve, as in a groove. When it leaves the auditory nerve, it passes on through the bone, and emerges on the side of the face through the stylomastoid foramen at the root of the styloid process, so as to come out betwixt the lower jaw and the ear, covered, of course, by the parotid gland. The portio dura, while passing through the canal of the temporal bone (which is the aqueduct of Fallopius), gives off a branch which unites with the Vidian nerve of the fifth pair: or rather, we may conclude with the best authors, that it receives a branch which comes retrograde from the vidian nerve, passing through the small hole on the anterior surface of the petrous part of the temporal bone. The portio dura, when it has proceeded onwards by the side of the tympanum, gives off one or more very minute branches to the muscles within the tympanum, which give motion to the small bones of the ear. A little further on, this nerve gives off a more remarkable branch, which passing across the tympanum, is called CHORDA TYMPANI. This is the branch, which, as we formerly mentioned, joins the gustatory branch of the lower maxillary nerve. The chorda tympani passes into the tympanum by the hole in the pyramid: it takes its course on the membrane betwixt the long process of the incus and the handle of the malleus; it is then received into a groove of the bone, it passes by the side of the Eustachian tube, and after enlarging considerably, it is united with the gustatory nerve as described.

When the portio dura, has escaped from the stylomastoid foramen, but is yet behind the condyle of the lower jaw, and under the parotid gland, it gives off, 1st, The posterior auris. This has connection with the first cervical nerve, and passing up behind the ear, it is connected with the occipital branches of the third cervical nerve. 2d, The nervus stylo-hyoideus to the styloid muscles, and here it unites with the sympathetic. 3d, A branch which supplies the deep muscles, and joins the laryngeal branch of the eighth pair.

The portio dura, rising through the parotid gland, spreads out in three great divisions, and where it divides, the membranes connecting the divisions are like webs betwixt them, and this has acquired for this division, the name *pes anserinus*. Here indeed, a sort of plexus is formed, so that anser or rings characterise this part of the nerve.

1. An ASCENDING BRANCH, which divides into three temporal or jugal nerves; so called, because they ascend upon the jugum, or zygomatic process, to the occipito-frontalis muscle. Two orbitary nerves, which passing up to the orbicularis muscle, branch upon it and inosculate with the extremities of the fifth pair. These branches of the portio dura to the muscles of the eye-lids are the sole movers of the muscles here, and if they be destroyed by tumor, abscess, or the knife, the eye-lids remain open and the eye-ball exposed.

2d. The SUPERIOR FACIAL BRANCH passes out from the upper part of the parotid gland, across the face to the cheek and orbicularis muscle of the eye. The middle facial nerve passes from under the risorius Santorini; it goes under the zygomatic muscle, and encircles the facial vein; it sends branches forward to the lips, and upwards to the eye-lids, and to unite with the infra-orbital nerve. There IS AN INFERIOR FACIAL NERVE, which comes out from the lower part of the parotid gland passes over the angle of the jaw, and is distributed to those fibres of the platysma myoides which stretch up upon the face, and to the risorius Santorini: it passes on to the angle of the lips, and is distributed to their depressor muscle. Betwixt those facial nerves there are frequent communications, while they are at the same time united with the extremities of several branches of the fifth pair before piercing the substance of the muscles.

3. The DESCENDING BRANCHES pass along the margin of the jaw, down upon the neck, and backward upon the occiput. Thus we see that the portio dura is well named the communciating nerve of the face. It is distributed to the side of the face, head, and upper part of the neck: it unites its extreme

branches with those of the three great divisions of the fifth pair, with the eighth and ninth, with the accessory of the eighth pair, with the second and third cervical nerves, and with the sympathetic. From those various connections the portio dura has also been called the *lesser sympathetic*. The connection of the nerves of the face, throat, and neck, with the nerves of respiration, affords one of the most curious subjects of inquiry as connected with expression.*

(The PORTIO MOLLIS of the seventh pair of nerves is the acoustic or auditory nerve; which shall be considered in a more particular manner when we describe the organ of hearing.)

## FURTHER ILLUSTRATION OF THE FUNCTIONS OF THE NERVES OF THE FACE AND HEAD.

I shall add here some familiar instances and cases to show the importance of the knowledge of the nerves of the face in the investigation of disease. The reader has only to take with him these facts: 1. The branches of the fifth nerve bestow sensibility to the head and face: 2. The same nerve supplies the muscles of the jaws for mastication: 3. The portio dura is the muscular nerve of the face, it combines the muscles with the acts of respiration, and is the source of all expression in the face.

" *J. Richardson*, October, 1820. — On first looking at this man, there does not appear to be any thing unusual in the state of his face; but the moment he speaks or smiles, the mouth is drawn to the left side. When he laughs, the distortion is increased; and when he sneezes, the difference between the two sides is quite extraordinary.

" On holding ammonia to his nose, it was observed that he could not inhale freely with the right nostril; and, on examining the state of the muscles, when the

* This opinion I beg leave to let remain as in former editions, as implying my conviction of the importance of those nerves which I have since proved.

act of sneezing was excited by the ammonia snuffed up by the left nostril, it was found, that not only those of the right side of the nose and mouth, but also of the eyelids, were passive, while all the muscles of the left side were in full action. When he blew, or attempted to whistle, the air escaped by the right angle of the mouth, the right buccinator not at all corresponding in action with the muscle of the left side, nor with that of the muscles of the chest and neck, by which the air was expelled. The sensibility of the paralyzed cheek was equal to that of the other side, and he could close his jaws with equal force on both sides."

The early history of the case, according to the account given by the patient's friends was this: —

"He was seized with a severe pain under the ear, and in a short time became so delirious, and his face so distorted, that the people in whose house he lodged, supposing him to be mad from brain fever, carried him to the parish work-house. There he lay until his friends discovered him, and brought him into the hospital. It was then found, that the phrensy which had led the people of the lodging-house to suppose that he was mad, was only a high state of delirium, in consequence of a severe attack of cynanche parotidea; indeed, the inflammation had run so high, that an abscess formed and burst under the ear. When the swelling subsided the degree of paralysis was very observable.

The delirium and the paralysis of the face naturally led the medical gentlemen, who first saw this patient, to suppose that the symptoms were caused by an affection of the brain. Luckily, the treatment generally followed in cases of phrenitis, was best adapted for the particular affection which had caused both the delirium and the paralysis. The portio dura being engaged in the inflammation under the ear, was the true cause of the paralysis."

For the next case I am indebted to a physician in Worcester: —

*Worcester, July* 25, 1824. — "Dear Sir: —My acquaintance with the nature of your late researches upon the functions of the nerves induces me to send you the following case: —

"A young gentlemen, aged 14, residing in the village of Kempsey, in this county, was observed by his family to have the expression of his countenance much altered. As long as the features were quiet nothing unusual was observable in the countenance; but as soon as any passion was excited the expression of the face was so different to what was natural to to him, that his brothers and others of the family complained of his 'making faces at them.' He, in fact, only smiled, laughed, or frowned upon the left side of his face, the muscles of the right side remaining inactive; and, as they passively yielded to the contraction of the muscles of the left side, the countenance, of course, was much distorted whenever these were called into action. He lost the power of whistling, and, for the same reason, of blowing, and was unable to close his right eye. The sensibility of the right side was as perfect as that of the left. He was quite unconscious of any change in himself, and was not at all aware of the distortion of his countenance when he smiled, &c. This affection did not occur suddenly, but seemed gradually to increase, and became so evident in the course of a week, as to induce the father of the young man to send for his apothecary, Mr. Bick, of Kempsey. When Mr. B. saw him he found the symptoms as above stated; but upon examining the right side of the face more minutely he discovered a fulness immediately beneath the right ear, produced by a hard, fixed, and indolent tumour, lying between the ramus of the lower jaw and the mastoid process of the temporal bone.

"He ordered him some aperient medicine, and directed the tumour to be rubbed with camphorated oil. In a fortnight the tumour disappeared, and with it, gradually, the paralysis of the muscles of that side of the face. It is a fortnight since Mr. Bick first saw

him, and he has now recovered every power, excepting that of blowing or whistling. I saw him several times during the progress of his cure. It appears to me that the portio dura of the seventh pair was, in this case, injured by the pressure of an enlarged gland soon after its emergence from the stylo-mastoid foramen, and that upon the removal of the pressure its functions were restored.

"I remain, dear sir, your obedient servant,

"JONAS MALDEN, M.D."

The danger to which the eye is exposed by paralysis of the portio dura, or by any operation on the face, in which its functions are not attended to, is well illustrated by the following case: —

"This poor man, about nineteen years ago, was attacked by a severe pain accompanied with discharge from the right ear. After a paroxysm severer than usual, he found, on getting up one morning, that the right side of his face was paralytic. His present condition, and the description which he gives of the progress of the symptoms, prove that the same results followed this paralysis, as in the instances already related. But what this poor fellow particularly laments is, that since the day he was first attacked, he has not been able to close his right eye; and well he may regret this, for the constant exposure of the eye to the light and dust has been the cause of many attacks of inflammation, and, consequently, of opacity of the cornea, so that the vision is now entirely lost. This, I fear, will often occur in similar cases, for I have observed that the eye has always become inflamed in those animals in which the portio dura has been cut. It is worthy of remark, that the inflammation has been more severe in the dog and in the ass than in the monkey. One great source of the increase of the inflammation is the purulent secretion from the conjunctiva; this the monkey wiped away with his hand; but it lodged between the eyelids of the dog and of the ass, so as to form an additional source of irritation."

The ultimate effects of the loss of power over the muscles of the face, in consequence of an affection of the portio dura, are shown in the following extract:—

"A most remarkable appearance in the face of Garrity is the wasting of all those muscles of the face which are subservient to respiration and expression. His cheek is so thin that when he speaks it flaps about as if it were only skin, and the corrugator supercilii and occipito-frontalis, which are principally muscles of expression, are so wasted, that we might, at first sight, suppose they had been removed by operation, and that now the bones were only covered by skin. There can be little doubt that the wasting of these muscles has been in consequence of their long inactivity; since the masseter and temporalis muscles of the same side, which retain their office, are not at all diminished in size, being as large as those of the opposite side."

A curious example of a contrary effect produced on the growth of the muscles of respiration and expression, by an injury of the portio dura, was afforded in an experiment made upon a young dog. After the nerve was cut he was taught to snarl whenever a stick was held out to him; this being often repeated, the muscles of the side upon which the nerve was entire, became very strong, while those on the paralysed side rather diminished than increased as the dog grew older. In a few months the one side of the face was much larger than the other. Every day we see similar results following palsy of the muscles of the limbs.

Many instances will now occur to my reader of cases where the paralysis of the face, consequent on a local affection of the portio dura, has been mistaken for an attack of apoplexy, and the patient treated accordingly. In one case the patient, after having undergone the discipline of bleeding, purging, and starving, and after having had his head shaved and blistered, was suddenly cured by the bursting of an abscess in his ear.

In another case, the disease commenced with a violent pain below the ear, and in a short time one side of his face became paralysed. For this paralytic affection he consulted many eminent men. The first plan of treatment was bleeding, blistering, and starving, the disease being supposed to have its origin in the brain; but as he got rather worse than better under this treatment, he was put upon a course of mercury, which was carried to such an extent, that he lost several of his teeth. After he recovered from the bad effects of the mercury, he was recommended to attend only to the state of his digestive organs. But the blue pill had no effect upon the distortion. The last advice which this gentleman received was to wear an issue in his neck; with this, however, he has not complied, as he feared it would, like some of the other remedies, have the effect of rendering him more uncomfortable.

A great many cases, somewhat similar, have been presented to me by my pupils.

The first regards a patient who had suffered an attack of common apoplexy; it may be offered in example of that train of symptoms which is consequent on an affection of the original or symmetrical system of nerves, and as distinguishable from those which follow an affection of the superadded class. The second is of a man, in whom both the portio dura and the fifth had been injured by a blow; and the third is of a patient in whom both these nerves seem to have been affected by a disease within the skull.

J. Cooper. — This man's general appearance is completely that of an old paralytic, but the distortion of his face is more remarkable than usual, in consequence of the right or paralyzed side being marked with a red blotch.

The arm and leg of the same side are nearly powerless, his intellect is much impaired, and his memory gone. The history of his case was given very clearly by his wife; according to her account, her husband was, for the first time, attacked with apoplexy about

seven years ago; from this attack he gradually recovered, but at the end of twelve months he was a second time seized, and, since that period, he has had two distinct attacks every year; for the last two or three years he has been nearly in the same condition as at present.

*State of the cheeks and mouth.* — When he is made to laugh, the right cheek rises in the same degree with the left; when he blows (he always bursts into a laugh when asked to whistle), the buccinator of the right cheek is in as much action as on the other side. When his nose is irritated by snuffing ammonia, the actions of the muscles, preparatory to sneezing, are equal on both sides of the face. These phenomena prove that the muscles of both cheeks are perfect in their actions as far as they are regulated by the respiratory nerve; they stand in contrast with the state of the same muscles in the cases related, when the act of sneezing was excited.

The next inquiry related to the influence of the branches of the fifth pair of nerves.

The right cheek, and the right side of the mouth, fall lower than the left. When a piece of bread was put between the teeth and right cheek, the patient could not push it from its place, but was obliged to pick it out with his tongue. The saliva constantly flows from the right side of his mouth, and when drinking, part of the fluid escapes from the same side. The loss of the sensibility of the orbicularis oris was farther shown by the inability to hold a pencil or a tobacco-pipe in the right side of his mouth.

The comparative degree of sensibility in the two cheeks was next examined; when he was pricked on the right cheek with a needle he seemed perfectly insensible, even though I drew blood, but on giving the least prick to the left side, he immediately started; the same difference in the degree of sensibility was observable in pulling a hair from each whisker (the sensibility of the right and left limb corresponded with that of the cheeks).

On putting hartshorn to the right nostril he inhaled it as well as with the left, and immediately all the symptoms observable in a person about to sneeze were presented.* As the nose was turned up, and the alæ nasi of both sides were equally in action, this was a sufficient proof of the state of the paralyzed side being here very different from the condition described in the foregoing cases. The influence of the fifth pair within the nose was tried : by tickling the inside of the right nostril no effect was produced ; but on tickling the left nostril the symptoms of sneezing were evident.

The motion of the eye was perfect.

He could close the eyelid of the paralyzed side as well as the other ; and when his nose was irritated by the hartshorn, or when he laughed, the orbicularis oculi and corrugator supercilii were in complete action, so that there was not here that heaviness in the expression of the upper part of the face, which is so remarkable in paralytic persons. Here, then, was proof that those actions of the eyebrows which we find to be deficient, when the portio dura is affected, are, in a case of common palsy, left entire ; indeed, we may have daily opportunities, while walking in in the streets, of observing that patients with palsy of one side of the body, have no difficulty in closing the eyelids.

In the next Case, both systems of nerves seem to have been affected.

Phipps, a bricklayer, on the 1st of September, 1821, fell from a scaffold thirty feet high. His right clavicle was broken, his right loin and hip were much bruised, and he received a severe contusion on the head, the marks of which were particularly observable in a puffiness behind the right ear, and in bleeding from the same ear and from the nose.

* The apparent sensibility of the nostril over which the fifth had lost its influence may be explained, by supposing that the fumes of the ammonia passed by the posterior nares to the other nostril, and thus caused sneezing.

He was in a state of stupor when brought into the hospital, but from this he recovered in the course of the day. For the two or three first days he appeared to suffer only from the effects of *concussion*, never having any of those symptoms which are generally attributed to *compression*. On the fourth day it was observed, that the angle of the mouth was drawn rather to one side, and there was also a degree of inequality in the contraction of the pupils.

On the sixth day it was remarked, that while he was asleep, the right eye was more than half open, while the left was closed.

The notes of the case are very full up to the 24th of September, and show that the patient had, during the interval, gone through the common series of symptoms which accompany that slight inflammation of the brain which is often the consequence of concussion.

On the 1st of October, he was made an out-patient, his face being, at this time, very much distorted.

The general appearance of his face at this time was that of a man who has suffered paralysis from apoplexy. But it was further remarkable, that when he spoke or laughed, the distortion was much increased, the mouth being pulled more to the left side than I ever saw in any other patient.

The following are the notes that were taken at this time. There appears to be total paralysis of the muscles of the right side of the face. When he smiles or laughs they are passive, while those of the left are regularly in action. If he attempts to whistle, he cannot close his lips sufficiently; when he blows, the right cheek is dilated, but passive, like a distended bladder; he can smoke, by putting the pipe into the left side of his mouth; he throws the smoke out of the right side, but in doing this, the action is evidently confined to the muscles of the left cheek.

The cheek and mouth hang down, as in the common case of hemiplegia—he cannot by a voluntary act move his cheeks; when a piece of bread is put

between the cheek and teeth of the right side, he cannot push it out with the buccinator, but picks it out with his tongue. He cannot hold his pipe or my pencil with the right side of his lips. These may be considered as sufficient proofs of the total paralysis of the muscles of the face.

The difference of the sensibility in the two cheeks was very distinct. When a hair of the right whisker was pulled, he was not conscious of pain; but he started immediately on pulling one from the left. When his cheeks were pricked with a needle, his expression was — "I feel you push against the right side, but in the left you prick me." When he brought his jaws forcibly together, he said he was not conscious of striking his teeth on the right side, though he felt them most distinctly on the left. On examining the state of the nose, we found that it was impossible to excite the muscles of the right nostril to any action.

The state of the right eyelids and eyebrow corresponded with those of patients who have paralysis of the portio dura, for both the orbicularis oculi and corrugator supercilii were so completely paralytic, that he could neither close his eye, nor knit his brow on the right side.

On examining how far the branch of the fifth, which passes to the eye and eyelids, was affected, we found that the symptoms did not exactly correspond with those observed in the parts regulated by the other divisions of the fifth pair, and particularly in the degree of sensibility; for when a hair was pulled from each temple, or from the eye-brows, the pain felt in the two sides was nearly the same; neither the temporalis, nor masseter muscles of this side were paralyzed. The motions of the eye-ball were so far perfect, that he could follow an object carried before him, but he could not direct both eyes truly, he saw double. The contraction and dilatation of the pupil of the right eye, were much the same as in the other eye.

He can put out the tongue, and move it in every direction with the greatest ease: the motions are all apparently correct and natural; he can throw a morsel from one side of the mouth to the other, and towards the throat, and he can pick it out from between his cheek and teeth.

These observations led us to conclude, that not only the motor linguæ, or ninth nerve, but also the glosso pharyngæal were perfect.

This case differs from the common examples of partial paralysis of the face, not only in there being evident marks of paralysis while the muscles of the face are at rest, but in the sensibility of the skin of the same side being in a great measure destroyed. It differs also from the case of hemiplegia.

The first difference which we observe in it, from the case of common hemiplegia, is, that the paralysis is confined to the face. Secondly, that the paralysis is on the same side with that on which the head is injured. Thirdly, that the palsy is more evident when the patient is made to sneeze or laugh. From these circumstances, we may conclude that there was here an injury of the skull affecting both the fifth and the seventh nerve, i. e. in their course, not in the brain.

" *James Gulland*, ætat. 26. — Was admitted into the Middlesex Hospital, April 15, 1823. His mouth and left cheek are twisted towards the right side: the whole surface of the left side of his face is insensible: he has not the power of moving the eye of that side, and it was lately become inflamed; he complains of a deep pain in the temple of the same side.

" His trade has been so profitable as to enable him to live in a most dissipated manner during the last five years. He has frequently strolled about the streets at night in a state of drunkenness, and has for three weeks never thrown off his clothes, and has been seldom in bed. He has been twice affected with syphilis; he was confined by his first attack for eighteen months, during which time he was under the influence of mercury. After regaining

his health, he frequently experienced a pricking pain in his left eye and temple, so severe as to prevent his reading, especially by candle-light. About twelve months ago he was knocked down: he fell on the back of his head, and wounded the occipital artery; he thinks that he has never been quite well since that time. On the 13th of October, last year, one of his comrades noticed to him that his mouth was drawn to one side; this induced him for the first time to observe in a looking-glass the condition of his face. He tried to spit, and observed that his saliva, instead of passing through the centre, was squirted out of the right corner of his mouth, which was contracted. His lips were in other respects perfectly natural, being possessed of sensibility and the power of motion. He could then likewise close the eyelids of the left eye, but to do this he required to shut the other eye also.

"On the following morning he was conscious of a peculiar numbness above the left eye. This numbness imperceptibly and gradually spread over the left cheek, and at the same time affected the external and internal surfaces of almost all that side of his head. He lost the sense of taste on the left side of his tongue, and in little more than a fortnight he became deaf in the left ear. Now he complains principally of the inflamed condition of the left eye, (which commenced about ten days ago,) and of the pain in his left temple.

"The above circumstances he himself could relate distinctly; the following is an account of his present condition, April 20.

"The left side of his face is drawn towards the right, and is slightly œdematous. The left nostril is collapsed, and does not expand during breathing. The mouth is distorted towards the right side. When he speaks, the two sides of his face are distinctly marked by a line of division; the action of the muscles of the mouth and nostrils, on the right side, being quite distinct, while those on the left are motionless. He

has lost all power over the left eye-lids; until lately, he could elevate his upper eye-lid, although, since the time of his first attack, he has always experienced a certain difficulty in closing it.. At present the eye-lid hangs down flaccid and shut; he is unable to press the eye-lids together.

" The sensibility to touch is gone on the greater part of the left side of his head and face, and this insensibility extends to the vertex of the head. The surfaces of the conjunctiva and eye-lids are also completely insensible, yet the eye is inflamed and ulcerated; the left side of the nose, the cheek, the upper and lower lips, are all equally insensible; but he is sensible when touched upon the left side, below the under jaw, and even over the lower jaw itself, as high as the inferior part of the lower lip. The external ear, and likewise the back part of his head, nearly as high up as the vertex, retain their natural sensibility.

" The internal surfaces of the left nostril, and of the mouth and gums on the same side, are insensible to touch; and he has neither the sense of taste or common feeling in this side of the tongue; in consequence of this, portions of food have sometimes lodged within the left side of his mouth, without his being aware of their presence, until they became actually putrid.

" The power of moving his tongue is quite perfect: if at rest, it lies in its natural position within the mouth; nor is it dragged towards either side when he is told to move it. Being tickled with a probe on the left side of the root of his tongue, the sensation of nausea and the effort of retching are produced as on the opposite side. He can open and close his jaws; yet it can be observed, when he is made to clench his teeth, or to bite forcibly, that the masseter and temporal muscles of the right side are hard, rigid, and strongly in action, while the same muscles belonging to the opposite side are totally different in that respect, for they feel soft and flaccid.

"With regard to his left eye, it has been already noted, that it is deprived of common sensibility, and that he has no power of shutting or raising his eye-lid. Besides these, he possesses no command over the eye-ball: his eye remains fixed and motionless, and directed straight forwards when he attempts to turn it towards objects. No motion exists in the pupil when a light is presented to the eye. He has the power of vision, although he sees dimly; this is, probably, on account of the eye being inflamed and the cornea ulcerated and opaque. When both his eyes are closed, he is sensible of a red light in the left eye, while nothing is visible in the right one.

"He was questioned as to the period when he observed that he had lost the power of directing the left eye to objects, but he was unable to inform us, because he imagined always that that eye was as much in motion as the other.

"August 1824. — This man is still alive, several of the symptoms of paralysis both of the portio dura and of the fifth are become more indistinct; he has regained a little power over the motions of the eye-lids, and of some of the muscles of the face, and the surfaces are endowed with a slight degree of sensibility."

In this case we may observe, that the symptoms show the affection to be limited to the seventh and fifth nerves of the left side, and they best correspond with the supposition, that a disease of the bone, or membranes, has affected these nerves in their course, and is gradually extending forward to the nerves of the orbit.

I shall close the narration of these cases by the statement of a circumstance which occurred to me a few years ago: —

A gentleman, in the vigour of life, came into my room to consult me, having the most remarkable distortion of countenance I had ever seen. He proceeded to state to me what he conceived to be the cause of this paralytic affection of one side of his

face: he had been knocked down by a blow upon the ear, and had remained a whole night insensible, with bleeding from the ear, from which time his features had been thus drawn to the opposite side. I thought I should give him comfort by stating to him that this was a paralysis attributable to the injury of the bone, and that, as it had not proceeded from an apoplectic tendency, there was no danger of a future attack or of increase of the paralysis. But this was not what he expected from me; he had consulted my brother, then at Rome, and he had proposed to cure him by an operation.

I was quite at a loss to conceive what operation his ingenuity had contrived to relieve so remarkable a deformity. This gentleman mentioned that it had been intended to make three small incisions on different parts of his face, so as to restore the balance of his features: and he was obviously disappointed in finding me less intelligent, or less able than he had expected, and we parted.

On reflecting on the conversation of this gentleman, it occurred to me, that my brother, believing that the paralysis had arisen from an injury of the fifth nerve, had proposed to restore the features to an equilibrium by dividing the branches of the same nerve on the opposite side; trusting, no doubt, to the features being still animated by the seventh pair of nerves. A singular consequence would have resulted from such an operation. The features would have remained drawn to the same side as before, and he would have been deprived of all sensibility of that side! If it was designed to have cut the *portio dura* of the side contracted, a more unhappy consequence would have resulted; for he could never afterwards have spoken, or even have kept his lips to his teeth, or retained the saliva. The features of both sides would have fallen in relaxation, and the eye would have remained uncovered, and he would have lost his sight by the inflammation and opacity consequent on its continual exposure!

It must, indeed, appear a singular circumstance now, that so many surgeons were cutting the branches of the fifth pair of nerves for the tic doloureux, without being led to enquire more particularly into the functions of the several nerves of the face. We see how near my brother's ingenuity was leading him wrong, from having often cut the fifth pair without producing horrible distortion. And I believe that the very same mistake led an honourable baronet to say that I had not cut the frontal branch of the fifth pair of nerves on the face of a nobleman, when I had only cut that branch without interfering with the branches of the *portio dura*, and consequently without producing the slightest effect on the muscles of the eyebrow. All these circumstances, I hope, tend to enforce the importance of anatomy.

At this stage of the description of the nervous system we experience some difficulty; for if we follow, undeviatingly, the manner of Willis, we shall certainly fall into the same mistakes. Instead of following the nerves of the brain and spinal marrow according to their regular succession, it will be necessary to class them according to their functions. This will oblige us to throw together some of the nerves of the brain, and some of the spinal marrow.

## OF THE RESPIRATORY NERVES, MORE PARTICULARLY, VIZ. THE GLOSSO-PHARYNGEAL NERVE, PAR VAGUM, SPINAL ACCESSORY, DIAPHRAGMATIC NERVE, AND EXTERNAL RESPIRATORY NERVE.

### ORIGINS OF THE RESPIRATORY NERVES.

The nerves on which the associated actions of respiration depend, and which have been proved to belong to this system by direct experiment and the induction from anatomy, arise very nearly together. Their origins are not in a bundle, or fasciculus, but in a line or series, and from a distinct column of the spinal marrow. Behind the *corpus olivare*, and anterior to that process which descends from the cere-

bellum, the *corpus restiforme*, a convex strip of medullary matter, may be observed; and this convexity, or fasciculus, or *virga*, may be traced down the spinal marrow, betwixt the sulci, which give rise to the anterior and posterior roots of the spinal nerves.

This portion of medullary matter is narrow above where the *pons Varolii* overhangs it. It expands as it descends; opposite to the lower part of the *corpus olivare* it has reached its utmost convexity, after which it contracts a little, and is continued down the lateral part of the spinal marrow.

From this track of medullary matter on the side of the *medulla oblongata*, arise in succession, from above downwards, the *fourth* nerve; the *portio dura* of the seventh nerve; the *glosso-pharyngeal* nerve; the nerve of the *par vagum;* the *nervus ad par vagum accessorius;* the *phrenic*, and the *external* respiratory nerves.

It is probable that the branches of the intercostal and lumbar nerves, which influence the intercostal muscles and the muscles of the abdomen in the act of respiration, are derived from the continuation of the same cord or slip of medullary matter. Nor will it escape observation, that the nerves called phrenic and external respiratory, though coming out with the cervical nerves, do, in all probability, take their origin from the same portion of the medulla spinalis with the accessory nerve.

The intercostal nerves, by their relations with the medulla oblongata, are equal to the performance of respiration, as it regards the office of the lungs; but they are not adequate to those additional functions which are, in a manner, imposed upon the respiratory apparatus, when they are brought to combine in other offices.

### OF THE MUSCLES OF THE TRUNK, WHICH ARE BROUGHT IN AID OF THE COMMON RESPIRATORY MUSCLES.

If we look upon the frame of the body for the purpose of determining which are the muscles best

calculated to assist in the motions of the chest, when there is an increased or excited action, we shall have little difficulty in distinguishing them, and we shall have as little hesitation in assigning a use to the nerves which supply these muscles exclusively. For these nerves have the same origin: they take an intricate course, threading and passing betwixt other nerves and other muscles, to be entirely given to the muscles which heave the chest.

In this enquiry it is necessary to observe, that the life of animals is protected by a particular sense which gives rise to an instinctive motion of drawing the breath, and by which the chest is suddenly and powerfully expanded on exertion or alarm. The start, on sudden alarm, is accompanied with a rapid expansion and rising of the chest, and the voice, at such a moment, is produced by suddenly inhaling, and not by expiration; and this expansion of the chest combines with the preparation for flight or defence, since the extension of the muscles lying on the breast and back is produced by this motion, and since they are thereby rendered more powerful in their influence upon the arms or anterior extremities. It cannot escape observation, that oppression and difficulty of breathing is exhibited in gasping and forcible inspiration, in drawing the breath, not in throwing it out.

Accordingly, when we examine the trunk of the human body, we have no difficulty in distinguishing the muscles most capable of raising the chest; and these, in effect, we see powerfully influenced in deep inspiration, whether the action be voluntary, as in speech, or involuntary, as in the last efforts of life, when sense is lost. They are the mastoid muscle, the trapezius, the serratus magnus, and the diaphragm.

1. Sterno-cleido-mastoideus. — This muscle, by its attachment to the sternum or breast-bone, raises or heaves the chest; and the operation of this muscle is very evident in all excited states of respiration,

in speaking, and still more in singing, coughing, and sneezing. But there is something necessary to the full effect of this muscle on the chest, for otherwise it will be a muscle of the head, and not of the chest.

2. The TRAPEZIUS must fix the head or pull it backwards before the *mastoideus* can act as a respiratory muscle, and how they are combined we shall presently see. The position of the head of the asthmatic, during the fit, as well as the posture of the wounded or the dying, prove the influence of the upper part of the trapezius in excited respiration.

The trapezius has a still more powerful and important influence in respiration when the action rises above the ordinary condition, and that is by drawing back the scapula, to give the necessary effect to the action of the serratus magnus.

3. The SERRATUS MAGNUS ANTICUS being extended over the whole side of the chest, and attached in all the extent from the second to the ninth rib, is very powerful in raising the ribs; but it cannot exert this power, independently of the trapezius, since, without this combination, its force would be exerted in moving the scapula, and not the ribs; unless the scapula be fixed, or pulled back by the *trapezius*, the *serratus* is not a muscle of respiration.

In this manner do these three powerful muscles hang together in their action, combining with the diaphragm to enlarge the cavity of the chest in all its diameters.

The course of our enquiry leads us to ask, Are these muscles privileged above others by any peculiarity of nerves? And the answer is plain: To these muscles alone, are the nerves, which I am about to call respiratory nerves of the chest, distributed.

## ANATOMY OF THE RESPIRATORY NERVES OF THE PAR VAGUM.

The PAR VAGUM, or as we are to describe it, *nervus vagus*, is one of three nerves which Willis describes as the eighth pair of nerves, viz. nervus

vagus, glosso-pharyngeus, and spinal accessory. These go out through the foramen lacerum, formed betwixt the occipital and temporal bone.

### THE GLOSSO-PHARYNGEAL NERVE

Is the first to be described. This nerve, parting from its connection with the par vagum and accessory nerve, perforates the dura mater separately from them, and in many subjects, passes through an osseous canal altogether distinct. When it escapes from the cranium, it lies deep under the angle of the jaw, and passes across the internal carotid artery upon its outer side. It is to be seen by lifting the styloid muscles, at which point it sends small branches to the styloid and digastric muscles, and to join the par vagum. It sends also some very small twigs down upon the internal carotid artery; some of which join that pharyngeal branch * which is formed from the par vagum and accessory nerve.

Several branches communicate with the ganglion and plexus, (expansio plexuosa,) of the pharyngeal nerve, and are distributed in the superior constrictor and the stylo-pharyngeal muscles.

The trunk of the glosso-pharyngeal nerve, after giving off the nerves which pass in the direction of the internal carotid artery, continues its course attached to the stylo-glossal and stylo-pharyngeal muscles, to which it gives more branches, and also to the upper division of the constrictor pharyngis. A division of the extreme branches of this nerve terminates in the tongue, under the denomination of RAMI LINGUALES PROFUNDI, RAMI LINGUALES LATERALES, NERVI GLOSSO-PHARYNGEI. † Amongst the

* This is a branch to the pharynx which is formed by the par vagum and the spinal accessory of Willis. After this nerve is formed, it again forms connection with the par vagum. — Pain in the throat having been observed by Galen to extend to the back, Scarpa explains it on the ground of this connection with the spinal accessory nerve.

† Scarpa. There is then a plexus formed, which is called the Circulus Tonsillaris Anderschii. It lies on the side and nearly on the dorsum of the tongue, and sends out some very delicate twigs to the tonsils.

branches of the pharyngeal nerve is to be enumerated, that which turns back to join the ninth pair in its distribution to the tongue.* The remaining branches of the glosso-pharyngeal nerve are distributed in innumerable filaments upon the pharynx; they are joined by branches from the ganglion of the sympathetic nerve. A remarkable branch of this nerve goes to the papillæ, on the surface of the posterior part of the tongue; and it is probably on the excitement of this, that the pharynx and tongue are brought into activity in swallowing.

I consider the glosso-pharyngeal to be the nerve of deglutition. I have elsewhere explained, that the act of deglutition is necessarily joined with that of respiration.

### PAR VAGUM.

The nervus vagus is the grand division: the middle fasciculus of the three nerves composing the eighth pair. It arises in filaments from that column of the lateral part of the spinal marrow which reaches up behind the corpus olivare. In its exit from the cranium, it is divided from the jugular vein by a small partition of bone. These filaments, indeed, sometimes pass out separately, and join to form the trunk of the nerve when out of the skull. Deep under the lower jaw, and the mastoid process of the temporal bone, the glosso-pharyngeal nerve, the par vagum, the spinal accessory, the sympathetic nerve, the portio dura of the seventh, and the upper cervical nerves, are entangled in a way which will fatigue the dissector. The par vagum, lying behind the internal carotid artery, and as it were escaping from the confusion of the ninth, accessory and glosso-pharyngeal nerves, descends and swells out into a kind of ganglion.† We now ob-

* Sabbatier.

† *Truncus gangliformis* OCTAVI, *tumidulum, corpus olivare* Fallopii; but it is suspected that in this he meant the ganglion of the sympathetic nerve.

serve three branches to be sent off: The FIRST and SECOND PHARYNGEAL NERVES, which pass to the constrictor pharyngis muscle, and the SUPERIOR LARYNGEAL NERVE. This last-mentioned nerve is even larger than the glosso-pharyngeal nerve. It is behind the carotid artery, and passes obliquely downward and forward. In its progress the principal branch passes under the hyo-thyroideus muscle, and betwixt the os hyoides and the thyroid cartilage; while others, more superficial, pass down, and are connected with the EXTERNAL LARYNGEAL, or PHARYNGO-LARYNGEUS; which is a nerve formed by the sympathetic and par vagum conjointly. The principal branch of the internal laryngeal nerve runs under the hyo-thyroideus, and is distributed to the small muscles moving the cartilages. The minute extremities of this nerve pass also to the apex of the epiglottis, and the glandular membrane covering the glottis. We have, at the same time, to remark, a very particular communicating nerve betwixt this internal laryngeal nerve and the recurrent branch of the par vagum. This branch is described by Galen. The par vagum continues its uninterrupted course betwixt the carotid artery and jugular vein; it is involved in the same sheath with these vessels, but lies rather behind them. In this course down the neck, it sometimes sends back a twig which unites with the ninth pair, and when near the lower part of the neck, it sends forward twigs to unite with those from the sympathetic nerve, which pass down to the great vessels of the heart, to form the superior cardiac plexus. On the right side, those nerves to the great vessels are in general given off by the recurrent nerve.

The nervus vagus now penetrates into the thorax by passing before the subclavian artery; it then splits into two. The main nerve passes on by the side of the trachea, and behind the root of the lungs; while the branch, on the right side, turns round under the arteria innominata, and on the left, under the arch of the aorta, and ascends behind the trachea to the larynx.

This ascending branch of the par vagum is the RECURRENT NERVE. On the right side it is sometimes double. It ascends behind the carotid artery, and sometimes is thrown round the root of the thyroid artery. On the left side, this nerve, from its turning round the arch of the aorta, is much lower than on the right, it gives off filaments which go to the lower cardiac plexus, after having united with the branches of the sympathetic. Under the subclavian of the right side, also, there are sent branches from the recurrent to the cardiac plexus; and on both sides there pass branches of communication betwixt the sympathetic nerve and the recurrent. When the recurrent nerve has turned round the artery, it ascends in a direction to get behind the trachea, and here it lies betwixt the trachea and œsophagus. It now sends off many branches to the back and membranous part of the trachea which pierce this posterior part, to supply the internal membrane. It gives also branches to the œsophagus and thyroid gland. The final distribution of this nerve is to the larynx. It pierces betwixt the thyroid and cricoid cartilages, and separates into many filaments, which terminate in the crico-arytenoideus, lateralis, and posticus, and thyreo-arytenoideus, and in the membrane of the larynx. We have already mentioned the branch of communication betwixt the recurrent and internal laryngeal nerves, and Sabbatier describes a branch of the recurrent, which sometimes ascends and joins the sympathetic high in the neck.

Two cases, mentioned by Galen, of scrophulous tumours in the neck opened, where the consequence was loss of voice, have tempted many anatomists to institute experiments on the recurrent and internal laryngeal nerves. * Notwithstanding the deep situation of those recurrent nerves, Galen says, they were cut in these cases, and he believed that the branch

* Martin, in the Edinburgh Essays, Professor Sue of Paris, Dr. Haighton, in the Memoirs of the Medical Society of London, Cruikshanks, Professor Scarpa, Arnemann, Majendie, &c.

of communication betwixt the laryngeal and recurrent restored the voice after some time had elapsed. Both the internal laryngeal and recurrent nerves are necessary to the formation of the voice. Experiments have been made upon them in dogs, and the result is curious; although the lesser changes of the strength, acuteness, and modulation of the voice could not be well observed in the lower animals. When the laryngeal nerve is cut, the voice is feeble, but acute; when the recurrent nerve is cut, there is a relaxation of those muscles moving the arytenoid cartilages which command the opening of the glottis, and in consequence the voice is flatter or graver, or more raucous.

The par vagum, after sending off the recurrent nerve, descends by the side of the trachea. Before it passes behind the vessels and branch of the trachea going to the lungs, it sends minute branches which form the ANTERIOR PULMONIC PLEXUS. This plexus is entangled in the connections of the pericardium, and is dissected with difficulty. The branches of this plexus throw themselves round the pulmonic arteries and veins, and follow them into the lungs.

The par vagum, passing on behind the root of the lungs, forms the POSTERIOR PULMONIC PLEXUS. From this also the nerves proceed into the lungs, by attaching themselves to the pulmonic arteries and veins, and bronchial arteries, and the branches of the trachea. *

* *Nerves of the Lungs.* — Galen, Vesalius, and others, conceived that there were very few nerves sent to the lungs, and that those which were, went only to the membranes, and not to the substance of the lungs. They believed also that the discharge of blood from the lungs and the existence of vomicæ without pain, while there was great pain in peri-pneumony, was a confirmation of this opinion. Fallopius corrected this idea, and shewed that the bronchiæ were also attended through their course with nerves. There often exist vomicæ and effusions of blood in the lungs; and Haller says, the lungs can be lanced without the animal feeling pain, but still the bronchiæ are extremely sensible. — Water accumulated in the interlobular cellular membrane, or the infraction of blood into it, gives no acute pain, but only a sense of weight and difficulty of breathing. It is an oppression in a great

The trunks of the nerve, continuing their course upon each side of the œsophagus, unite and split into branches, and again unite so as to form a netting upon the œsophagus; these are the ANTERIOR and POSTERIOR PLEXUS GULÆ, or ŒSOPHAGEAL PLEXUS. The par vagum, thus attached to the œsophagus, pierces the diaphragm with it, the anterior plexus unites again into a considerable trunk, and is attached to the lesser arch of the stomach. It stretches even to the pylorus, and sends its branches to the upper side of the stomach, and to the lesser omentum; at the same time it unites with the left hepatic plexus, some of its branches terminate in the solar plexus which surrounds the root of the cœliac artery. The posterior œsophageal plexus, likewise uniting again into a considerable cord when it has come into the abdomen, sends branches to encircle the cardiac orifice of the stomach; it branches also to the inferior side and great arch of the stomach; it sends also branches to the splenic plexus and solar plexus.

Thus we see that the par vagum has a most appropriate name, and that it is nearly as extensive in its connections as the sympathetic itself. It is distributed "to the œsophagus, pharynx, and larynx; to the thyroid gland, vessels of the neck and heart, to the lungs, liver, and spleen, stomach, and duodenum, and sometimes to the diaphragm." The recollection of this distribution will explain to us many sympathies; for example, the irritability of the larynx in exciting laughing; the hysterical affection of the throat when the stomach is distended with flatus; the exciting of vomiting by tickling the throat; the

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measure depending upon the return of the blood from the lungs, unchanged in consequence of the compression of the cells. In these observations they have not sufficiently distinguished betwixt common sensibility and the appropriate sensibility of the organ. Are not the stomach and intestines sensible? and yet they are not to handling.

The connection betwixt the stomach and bronchiæ, through the medium of the par vagum and pulmonic plexus, is evident from those asthmatic attacks which depend upon foulness in the stomach.

effect which vomiting has in diminishing the sense of suffocation; the relations betwixt the heart and lungs; the lungs and stomach, and the stomach and heart.

The nerves which give rise to the extraordinary intricacy of this system on the side of the neck, are the spinal accessory nerve, the phrenic nerve, and the external thoracic nerve. The phrenic nerve has its great root or origin from the fourth cervical nerve; and there joins this root, a more slender branch from the third cervical nerve. But, besides these roots, it has connections, which of themselves would mark the relations of the nerve; high in the neck, it is connected with the *nervus vagus* and with the *lingualis medius*, while, at the same time, a branch is given off to the muscles of the larynx. The trunk of the nerve descends into the cavity of the thorax, and gives no branches, until, arriving at the diaphragm, it sends out numerous diverging branches, which are lost in the substance of that muscle.

It has been long known that irritation of this nerve convulses the diaphragm, and that cutting it across paralyses that muscle. These facts, with the consideration of its course, prove it to be a respiratory nerve, and such has been the universal opinion.

But to what purpose should a distinct nerve be sent to the diaphragm, if the other muscles, seated externally, and which are associated in action with the diaphragm, and as important to respiration, were left without a similar tie to unite them with each other, and with the organs of the voice?

The *inferior external respiratory nerve* of the thorax (fig. 13. Pl. II.) is a counterpart of the internal or phrenic nerve. It comes out from the fourth and fifth cervical nerves, and often it is connected with the phrenic. It diverges somewhat from that nerve, because, instead of descending within the chest, it falls over the ribs, and descends in a distinct flat trunk upon the outside of the chest, to be distributed entirely to the *serratus magnus anticus*. This

muscle has other nerves coming from the spinal marrow, because it has to combine the motions of the frame in loco-motion. But the long descending nerve is a respiratory nerve; which we may know from its origin, course, and destination; in its origin and course it is like the diaphragmatic nerve, and in its destination also, since it is given to a muscle necessary to full inspiration.

I come now to the *spinal accessory nerve* (fig. 11. Plate II.)* It is called here the superior respiratory nerve of the trunk. Experiments may take a colour from the preconceived idea, but the accurate investigation of the structure will not deceive us. The author, therefore, entreats attention to the anatomy of this nerve, as leading in the most conclusive manner to a knowledge of its functions.

It arises from the cervical portion of the spinal marrow; but instead of collecting its branches to go out by the side of the vertebræ, like the internal and external respiratory nerves, it shoots upwards through the theca of the spinal marrow, enters the skull, and joins the eighth pair of nerves; from which it has its term of accessory. We see the roots of this nerve as far down as the fourth cervical nerve.† These roots arise neither from the posterior nor the anterior column of the spinal marrow, but betwixt the posterior roots of the cervical nerves and the ligamentum denticulatum, and from the *column of medullary matter* above described. The origins of this nerve come off in one line, and that line is in the direction of the roots of the eighth pair, and of that nerve which has been proved to be the respiratory nerve of the face, the portio dura. In its ascent the accessory nerve is attached to the posterior root of the first cervical nerve.

The nerve having ascended through the *foramen magnum*, passes out from the skull associated with the

* *Nervus ad par vagum accessorius.*

† In the ass, its roots are seen to extend much lower down.

nerves constituting the *eighth pair*, and in the same sheath with them; they all go out through the *foramen lacerum*, and by the side of the jugular vein. In this course the accessory nerve divides into two. One of these divisions joins filaments of the *par vagum;* and these again send nerves to the *glosso-pharyngeal* nerve; and sometimes a branch may be seen going to the *lingualis medius*. The more exterior division of the accessory nerve descends behind the jugular vein, and comes forward and perforates the mastoid muscle. In its passage through the muscle it sends off branches which course through its substance; and if, as sometimes happens, though rarely, the nerve does not pass through the muscle, these branches are, notwithstanding, invariably given to it.

When the nerve has escaped from the back part of the mastoid muscle, it forms a communication with that branch of the third cervical nerve that ascends behind the muscle; and nearly at the same time it is joined by a branch from the second cervical nerve. The superior respiratory nerve now descends upon the neck, and begins to disperse its branches in regular order to the edge of the trapezius muscle; four or five branches take their course to that muscle, separate into minute subdivisions, and are lost in its substance. One more considerable division, being the lowest of these, is joined by a long descending branch of the second cervical nerve. Increased by this addition, it descends under the trapezius and behind the clavicle. Following this descending branch, it will be found exclusively attached to the trapezius. Behind the scapula it is again joined by branches from the spinal nerves; and here a sort of imperfect plexus is formed, from which divisions of the nerve, still descending, follow the lower edge of the muscle, and are finally dispersed among its fibres.

This nerve arises from the same column with the respiratory nerves; it takes a most intricate and circuitous passage to form a junction with nerves which

we know to belong to that class; it sends branches to join the nerves of the tongue and pharynx; it sends branches to the larynx in company with the branches of the *par vagum;* it then crosses the great nerves of the neck, passes under the spinal nerves, goes to no other muscles in its course, but lavishes all its branches on the mastoid and trapezius muscles. To an anatomist it is as plainly set forth as if it were written in our mother tongue, this is *the superior respiratory nerve of the trunk.* *

### COMPARATIVE VIEW OF THESE NERVES.

If we examine the *par vagum*, the *portio dura* of the face, the *external thoracic*, the *diaphragmatic*, and the *spinal accessory* nerves, by comparative anatomy, we shall conclude that they are all respiratory nerves, by their accommodating themselves to the form and play of the organs of respiration. In fishes, the respiratory nerve† goes out from the back part of the *medulla oblongata.* When it escapes from the skull it becomes remarkably enlarged, and then disperses its branches to the branchiæ and the stomach. But from the same nerve go off branches to the muscles moving the gills and operculum, whilst a division of the nerve is prolonged under the lateral line of the body to the tail. It is said, this division sends off no branches, but this is not correct; it gives branches in regular succession to the muscles from the shoulder to the tail. Experiments have been made upon these nerves, but their detail would lead us too far. It is scarcely necessary to add, that there are neither phrenic nor spinal accessory, nor external thoracic nerves in fishes, the order of their muscular system not requiring them. In birds, the structure of the wing, and the

* *Lobstein*, in a dissertation on this nerve, finding the difficulty of accounting for the *nervous fluid* coming by a double passage to the muscle, concludes, *veniet forsan tempus quo ista quæ nunc latent, dies extrahat et longioris ævi diligentia.*

† The nerve which by its subdivision supplies the heart, lungs, and stomach, and the muscles of the gills.

absence of the mastoid muscle, render the spinal accessory nerve unnecessary; it is wanting, for the same reason, that in the absence of the diaphragm there is no phrenic nerve. Quadrupeds have the three respiratory nerves of the trunk; but even in them there are variations in the muscular frame, which illustrate the appropriation of the nerves. The construction of the neck of the camel is like that of birds; there is a succession of short muscles along the side of the neck, and attached to the vertebræ; but there is no long muscle, like the *sterno-cleido-mastoideus*, contributing to the motion of respiration. There is, accordingly, no spinal accessory nerve in the neck of this animal.

We have a remarkable example of the manner in which these nerves vary in their course of distribution, and yet retain their appropriate functions, in the nerves of the neck of birds. In them, the bill precludes the necessity of the portio dura going forward to the nostrils and lips; the nerve turns backwards, and is given to the neck and throat; and it is particularly worthy of remark, that the action of raising the feathers of the neck, as when the game-cock is facing his opponent, is taken away by the division of this nerve. If we compare the anatomy of the facial respiratory nerve, in the various classes of birds, we shall find its distribution to be analogous to that of the same nerve in the different tribes of quadrupeds.

In the game-cock, a few branches of the nerves pass to the loose skin under the jaw, which is dilated in crowing, the greater number being distributed on the muscles of the neck, which causes the elevation of the feathers when he puts himself in an attitude for fighting. But in the duck, which, when enraged, has little or no power of expression, the same nerve is not larger than a cambric thread, and passes only to the skin under the jaw. *

* These respiratory nerves of the thorax, the diaphragmatic, the superior, and the external thoracic nerve, are all nerves of *inspiration*. The act of inspiration is provided for in a more especial manner than the act of expiration. It requires more

## THE FUNCTIONS OF THESE NERVES FARTHER ILLUSTRATED.

Before having recourse to experiments on brutes, we may observe what takes place in our own bodies. By placing the hand upon the neck, we may be sensible that the mastoid muscle has two motions. The lower extremity of the muscle is fixed when we move the head; but when we use the muscle in inspiration, the head, and consequently the upper extremity of the muscle, are fixed. Now, if we endeavour to raise the sternum through the operation of this muscle, we shall find that other muscles are, insensibly to us, brought into action, which have nothing to do with this raising of the sternum. For example, if we strain to raise the lower extremity of the muscle, we shall unavoidably produce an action of the muscles of the nostrils; by which association of actions, we shall discover, that we are using the *mastoideus* as a respiratory muscle. If we reverse the action, and move the upper extremity of the muscle, other muscles will be drawn into co-operation, but they will be such as assist in the motion given to the head. Or we may vary the operation in another way. In snuffing or smelling, if we place the fingers on the portions of the mastoid muscles which are attached to the sternum, we shall find every little motion of the nostrils accompanied with corresponding actions of the sternal portions of the muscles in the neck.

When a man suffers fracture of the spine at the

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muscular effort, and is more essential to life. Inspiration is the first act of resuscitated life, the last of exhausted nature, and for this reason the muscles of inspiration are large and powerful, and the nerves in a double order; for not only do the lateral branches of the spinal marrow influence the act of inspiration, but these additional respiratory nerves descend from the upper part of the spinal marrow to the chest, as an additional and especial provision, guarding life.

sixth cervical vertebræ, and the marrow is crushed, he continues to breathe by the influence of the three nerves which arise above the injured portion. He inspires with force ; but he cannot perform expiration by muscular effort, it is only by the elasticity and gravitation of the parts. He can yawn, for that is an action of drawing the breath ; but he cannot sneeze, for that is an action of expelling the breath. But this is a subject so curious in itself, and which has hitherto been considered so carelessly, that I shall reserve it for a distinct dissertation. *

A man having a complete hemiplegia, the side of his face relaxed, the arm hanging down powerless, and the leg dragged in walking, we were curious to know if the influence pervaded all the nerves of the side, or only the regular or voluntary nerves. Some trouble was taken to make him heave up the shoulder of the debilitated side, but to no purpose. He could only do it by bending the spine to the other side, and as it were weighing up the paralytic shoulder. But on setting him fairly in front, and asking him to make a full inspiration, both shoulders were elevated at the same time that both the nostrils were in motion. The respiratory nerve of the face, and the superior respiratory nerve, were entire in their office ; and, although the regular system of nerves refused acting, the *sterno-mastoideus* and the *trapezius* partook of their share in the act of respiration. Seeing that the mastoid muscle has two sets of nerves, that one of these is of the class of voluntary nerves, and the other of respiratory nerves, are we not borne out in concluding, that when the head is moved, being a voluntary act strictly, it is performed through the common class of voluntary nerves? that when the chest is raised, it is an act of respiration, and is effected through those nerves which controul the muscles in respiration?

This conclusion is confirmed by the following experiment. In the ass, there are two muscles which

* See the observations, p. 564.

take the office of the mastoid muscle; one is inserted into the jaw, which we may call *sterno-maxillaris*, and the other into the vertebræ, viz. *sterno-vertebralis*. To these the superior respiratory nerve (or spinal accessory) is distributed in its passage to the trapezius. These muscles are at the same time supplied with numerous nerves directly from the spinal marrow. If we expose the superior respiratory nerve, and then induce excited respiration, so as to bring these muscles into powerful action in combination with the other muscles of respiration, and if, while this action is performed, we divide the nerve, the motion ceases, and the muscle remains relaxed until the animal brings it into action as a voluntary muscle.

An ass being thrown, its phrenic nerves were divided, on which a remarkable heaving of the chest took place. It rose higher, and the margins of the chest were more expanded at each inspiration. There was no particular excitement of the muscles of the neck, shoulder, or throat, at this time; so that to excite the actions of these muscles it was necessary to compress the nostrils. When they began to act with more violence, keeping time with the actions of the other muscles of respiration, the superior respiratory nerve was divided; immediately the action ceased in the muscles attached to the sternum of the side where the nerve was divided, while the corresponding muscles of the other side continued their actions.

After dividing the spinal marrow between the vertebræ of the neck and those of the back, respiration is continued by the diaphragm: which experiment, as it is often mentioned by physiologists, the author has not thought it necessary to repeat, but only to institute the following experiment on an ass. The phrenic nerves being first divided, and then the spinal marrow cut across at the bottom of the cervical vertebræ, respiration was stopped in the chest; but there continued a catching and strong action at regular intervals in the muscles of the nostrils, face,

and side of the neck. The main part of the apparatus of respiration was stopped, but these accessory muscles remained animated, and making ineffectual endeavours to perform the respiration. When apparent death had taken place, the ass was re-animated by artificial breathing, and then these muscles on the face and neck were restored to activity, and became subject to regular and successive contractions, as in excited respiration, whilst the chest remained at rest. These actions continued for a short time, and then ceased, but upon artificial respiration being again produced, the same results followed. This was repeated several times, the animal remaining insensible during these experiments.

Upon stimulating the nerves after the death of this animal, it was observed, that the class of respiratory nerves retained their power of exciting their respective muscles into action, long after the other nerves had ceased to exert any power; they were evidently of that class which retain their life the longest.

It is a duty to avoid the unnecessary repetition of experiments, and I have now to make a short statement of facts, resting on the highest authorities: experiments made without reference to the conclusions which I am now to draw.

The division of the recurrent branch of the *par vagum* destroys the voice. *

The division of the laryngeal branch of the *par vagum* stops the consent of motion between the muscles of the *glottis* and the muscles of the chest. †

The injury or compression of the *par vagum* produces difficulty of breathing. ‡

By the assistance of these well-known facts, we

* Sectis ambobus nervis recurrentibus vox perit: *Arnemann, Soemmerring, Morgagni.*

† *Le Gallois.*

‡ Vinculo compressis nervis vagis oriuntur in bestiis spirandi difficultas, surditas, vomitus, corruptio ciborum in ventriculo. *Soemmerring, Haller, Brun de ligaturis nervorum.*

complete the knowledge of the circle of actions which result from the respiratory nerves.

The *medulla oblongata* and *spinalis* are composed of columns of nervous matter, and from the different powers of the nerves, as they arise from the one or other of these columns, it is proved that they possess distinct properties. In animals that breath by ribs and a numerous class of muscles, and which animals have a spinal marrow, we see that a column of nervous matter is embraced between the anterior and posterior *virgæ* of that body, and that this portion may be traced downwards between the roots of the spinal nerves. From the upper part of this column, where it begins in the *medulla oblongata*, the several nerves proceed which have formed the subject of these papers, and on the influence of which, it has been proved, the motions of respiration principally depend. It is not an extravagant conclusion to say farther, that the power of the regular succession of intercostal and lumbar nerves, as far as they regulate the respiratory actions, proceeds from the connections of the roots of these nerves with this column, which is continued downwards, and which can throughout be distinguished from the rest of the spinal marrow.

We are now enabled to distinguish the influence of the spinal marrow, and its regular succession of nerves, from those which have been traced in these papers. The first are essential to the act of respiration; without them the others are unequal to the task. But on the other hand, although the regular succession of spinal nerves be equal to the raising and depressing the thorax, they are not equal to the full heaving of the chest in animated exertion of the voice. They are not competent to the performance of the motions of the glottis, pharynx, lips, and nostrils, which several parts are necessarily influenced in excited respiration, as well as in the acts of smelling, coughing, sneezing, and speaking: for these,

the co-operation of the whole extended class of respiratory nerves is required.

Surveying the complicated machinery which in man is prepared for these various offices, we may reap the benefit of these fatiguing details, in the contemplation of the most interesting phenomena in nature. The relations of the subject may be presented under the heads of Pathology, and Expression.

## ON THE ACTIONS OF RESPIRATION IN THOSE WHO HAVE SUFFERED FRACTURE OF THE SPINE AT THE LOWER CERVICAL VERTEBRÆ.

When the spinal marrow is crushed at the upper part of the spine, the man dies instantly; but if the spinal marrow be crushed opposite to the lower part of the neck, although the injury be such as to deprive him of all sense and all voluntary motion of the parts below, he continues to breathe.

It has been stated by our first authorities, that a man in these circumstances breathes by his diaphragm, in consequence of the phrenic nerve, which supplies that muscle, taking its origin from the spinal marrow above the part injured. But the observations have been inaccurately made which have led to this opinion. I shall first show how untenable such a supposition is, and then detail the phenomena which attend the fracture of the spine at this part; and, finally, show that other nerves, besides the phrenic, descend from the same source to supply the exterior muscles of the chest, and that it is through their influence the act of respiration is continued.

The diaphragm is that muscular septum which divides the thorax and abdomen, and by the descent of which the depth of the cavities of the chest is increased in inspiration. When it has acted and descended, and the air is admitted into the lungs, that air is again expelled by the re-action of the abdominal muscles. These muscles compress the viscera, and by pushing

them up, raise the relaxed diaphragm, preparing it for another effort of inspiration. Is it not obvious, that if the power of the diaphragm remains entire, and the power of the abdominal muscles be lost, that the respiration must stop? It would be so, were it not that there are other muscles and other nerves no less important than the diaphragm and the phrenic nerves, and which physiologists have not contemplated.

In the first part of this paper it is shown that the *sterno-cleido-mastoideus*, the *trapezius*, and the *serratus magnus*, are muscles calculated, by their combined operation, to raise the chest with great force, and to perform inspiration. It is also shown that the nerves there described as the superior and the external respiratory nerves, take their course exclusively to those muscles which act upon the chest, and that what the phrenic nerves are to the diaphragm, these are to the three great exterior muscles. It is further shown by what has preceded, that as all these nerves take their origins from the same part of the spinal marrow, they are consequently in the same circumstances as to fracture of the spinal tube. When the spine is fractured at the lower cervical vertebræ, these nerves escape injury, and continue to animate the muscles exterior to the ribs as well as the diaphragm.

The great importance of these exterior nerves and muscles to the continuance of life will be proved by the following cases. I have purposely omitted all the detail of practice, and have taken the symptoms purely in a physiological view, and as if it were an experiment instead of a most afflicting accident to a fellow creature.

Within the space of one month these three instances of fracture of the vertebræ of the neck have occurred in my practice. In one instance, the bones were broken at the lower part of the neck, and the patient lived some days. In the second instance, the vertebræ of the neck were fractured in the middle of the neck, and the man lived half an hour. In the last

instance, the uppermost vertebra was fractured, and the death was immediate.

Case I. — *Percy Ward*, 29th May. — Charles Osborne, ætat. 26. — On Saturday evening this man was putting pulleys into a window-sash, when the small steps on which he stood slipped from under him, and he was precipitated through the window into the area, a height of 13 feet. He thinks he fell upon his back; but he is uncertain, as he lay for some time senseless. He lies now in bed, supine and powerless, but describes the part injured to be the spine betwixt the scapulæ. As we desired to have only the essential feature of this case, it is better to say at once, that this was a deception, that he felt the pain of the injury at a point considerably lower than the fracture, and that on his death it was discovered that the arches and bodies of the sixth and seventh cervical vertebræ were broken.

The lower extremities are motionless and insensible. He can raise his shoulders and bend his arm, but over the motion of the hands he has no power.

Another report adds, — his expression is singular; he says he can move his arm by the strength of his shoulders, which is exactly true, for by moving the shoulder he can give a certain rotatory motion to the humerus, and, consequently, move the fore-arm when it is bent at the elbow. The skin of the arms, however, retains its sensibility to the point of a pin. The abdominal muscles are relaxed, and the viscera feel flaccid. He can make no effort to expel the urine; his urine is drawn off by the catheter, and his fæces pass involuntarily: there is priapism. When I induce him to attempt an effort and to strain, no change on the abdominal muscles can be felt; there is no firmness or rigidity in them. The integuments of the abdomen and of the chest, as high as the nipples, are insensible.

His breathing is frequent, and at each inspiration the chest is heaved with a short and quick move-

ment; at each expiration the abdomen is protruded with a sudden shock and undulation. The belly, during this effort of breathing, is uniformly soft and full, and when drawn in it is by the elevation of the ribs, and when the chest falls it is protruded.

He has been observed to yawn naturally. Query. Can he cough?

An examination has been made to-day to answer this query. When he is asked to cough, he pulls up the ribs and extends the chest, and lets them fall: he coughs, but not strongly: it is obviously by his power of raising the chest and giving elasticity to the ribs, and by the weight of the parts falling, that he is enabled to expel the breath. He cannot divide the expiration into two coughs, nor give two impulses to the air; but each time he coughs the elevation of the chest must precede it.

On spreading the hands and fingers on the side of his chest the action of the serratus muscle could be felt, and also the lower margin of the trapezius muscle was felt to become firm during the act of inspiration, as when he prepared to speak.

Being asked if he had sneezed by any chance, his answer was — "No, sir; I cannot blow my nose." This was not that he could not raise his hand to his head: he was conscious of wanting the power of forcibly expelling the air. Mr. B., taking a handkerchief from a nurse, and holding the patient's nose as a woman does a child's, the patient could not blow the nose; he could not give that sudden impulse of expiration which is necessary.

In one of the reports of this case it was stated that the patient was disturbed by horrible dreams. This is very likely from the respiration being in part obstructed; but I omitted to verify that observation during the patient's life.

It is remarkable in this case, that on feeling his stomach he, of his own accord, marks the difference of sensibility, internal and external. He says he feels

internally, but he does not feel on his skin. He feels me when I press the stomach, and has complained of the griping from his medicines. Another instance proving that the par vagum is a compound nerve.

This man died in the night of the seventh day from the accident. The night nurse gave no particular description of the manner of his death, further than that he seemed to desire to speak and could not: he made attempts to articulate, but could not.

Case II. — James Saunders, ætat. 45, June 30. — This man fell only four feet, but he fell backwards, and struck his neck against an iron railing. The transverse processes of the fifth and sixth cervical vertebræ were found fractured; and there was diastasis of the articulations between these vertebræ. The body of the sixth vertebra was fractured. The spinous processes, also, of the fourth and fifth vertebræ were found fractured at their bases.

The house surgeon reports of this man, that when he was brought into the hospital he was perfectly sensible; that his face indicated great alarm and anxiety. Every time he drew his breath it was attended with an effort to raise the shoulders, and a contraction of the muscles of the throat: every time he breathed his head appeared to sink beneath his shoulders. On putting his hand on the pit of his stomach no motion of the viscera of the abdomen could be perceived. He had no feeling even in the upper part of his chest: he had feeling on his face and neck, and indistinctly near the collar bone. He had a motion of his hands, a sort of rolling motion, which may have proceeded from the shoulders. When he spoke it was in a tremulous voice, like a man frightened: his voice was weak, but he did not speak in a whisper: the sound of his voice was more like sighing than common breathing. Pulse was felt at his wrist. In ten minutes after he was brought in, half an hour from the time of the accident, he died.

Case III. — On the following day a man was brought into the hospital dead. He had fallen fifty feet, and had lighted on the ground upon both his shoulders. By the accounts of the men who carried him to the hospital, he appears to have been instantaneously killed. The dissection sufficiently proved that he was killed suddenly. For besides extensive fracture and injury to the lower part of the spine, the atlas and dentata were found likewise fractured. The tooth-like process of the vertebra dentata was broken through just at its base. It was separated completely, and was found embraced by the transverse ligament in its natural situation upon the atlas. The arch of the atlas was partially fractured on each side, and a portion of its body, where the process of the dentata rolls upon it, was also fractured and detached. *

* A young man was brought into the Middlesex Hospital, who had fallen upon his head. He soon recovered, and lay for some time in the hospital without exhibiting a symptom to raise alarm. He had given thanks to the assembled governors of the hospital, and had returned into the ward for his bundle, when, on turning round to bid adieu to the other patients, he fell, and in the instant expired. Upon examining his head, it was found that the margins of the occipital hole had been broken: no doubt it had happened that, in turning his head the pieces were displaced, and closed and crushed the medulla oblongata, as it passes from the skull.

A man was trundling a wheel-barrow in Goodge Street, which is immediately adjoining the Middlesex Hospital: in going from the carriage-way to the flag-stones he met the impediment of the curb-stone. He made several efforts to overcome it, and at length drawing back the wheel-barrow he made a push, and succeeded; but the wheel running forward, he fell, and remained motionless. He was taken into the hospital, but he was found to be quite dead. The tooth-like process of the second vertebra of the neck had burst from the transverse ligament of the first. The impulse given to the head had done this violence, and had at the same time carried forward the spinal marrow against the process, and on which it was crushed.

These cases occurred before my time, but I have had two instances of sudden death from the dislocation of the atlas from the second vertebra of the neck. In short, the fact is perfectly well ascertained.

In the above narratives we have the account of those symptoms which accompany fracture of the cervical vertebræ, and which have hitherto been negligently considered, from an entire want of interest in the subject. It appeared to me very distinctly, that, in the case first described, the man had the power of drawing his breath by muscular exertion; but that the expulsion of the breath was not a muscular effort, but occasioned entirely by the elasticity of the ribs, and the gravitation of the parts forcibly raised by the action of the muscles. This was evident in the total want of the power to exert the abdominal muscles, or to compress or depress the chest above its condition of rest; in the necessity of raising the chest at the utterance of each word; in the perfect power of yawning, which is a gradual and powerful act of inspiration; in the want of the power of sneezing or blowing the nose, which is a sudden call of the muscles of expiration into action.

The strongest reason of all for this view of the use of these nerves, which I have called respiratory, is, that respiration and the activity of the muscles of the chest did actually continue after the functions of the spinal marrow were destroyed by violence done to the tube, and that there is no other explanation of the fact than this, that those nerves which take their origin from the medulla oblongata and upper part of the spinal marrow, and which descend upon the neck and chest, did continue to animate the sterno-cleido mastoideus and the trapezius, and the muscles of the throat, in the act of inspiration. We have only further to recollect, that it was not the forcible, occasional, and voluntary motions of respiration that were thus preserved, but that by the same means, viz., the superior, the external, and the phrenic nerves, the play of the chest in respiration during sleep was continued.

In the second case, it is clearly proved, both by the symptoms and the dissection of the bones, that the fracture must have affected the roots of the phrenic nerves; and we are at liberty to conclude, that

the difference of symptoms, in comparing it with the first case, as well as the shorter period of his sufferings, was owing to this cause.

The manner of breathing was very different, and is described by our house surgeon * in a manner to produce conviction. *His breathing was like sighing;* and at each inspiration his head was drawn betwixt his shoulders. That is to say, that by the loss of the action of the diaphragm the action was thrown on the muscles exercised through the spinal accessory nerve, and this is confirmed by what is said of the want of motion in the viscera of the abdomen; for, as it was proved in the first case, at each contraction of the diaphragm the viscera of the abdomen are propelled outward.

The want or defect of action in the diaphragm, and the action of breathing being circumscribed to the muscles of the neck and shoulders, were undoubtedly the cause of the patient sinking so soon.

In the last case, it appears, the spinal marrow being injured so high up as to destroy the roots of all the respiratory nerves, the death was sudden, as in pithing an animal.

When we have ascertained these facts, certain queries are naturally suggested. Why should these respiratory nerves, which descend from above upon the thorax, go only to muscles which assist in raising and expanding the chest? Why should the act of inspiration be secured by a double provision of nerves, viz. those which come out from the sides of the spine, and those which descend from the neck, when the act of expiration is provided for solely through the former?

I would offer these reasons: —

*First.* The act of drawing the breath is the more difficult, and requires the more force; the act of expiration is comparatively easy, being assisted by the weight of the parts incumbent on the ribs, as well as the resiliency or elasticity of the ribs themselves.

* Mr. Turner.

*Second.* The act of inspiration is the active state; the condition of expiration is a state of rest.

*Third.* The inspiration is necessary to life, and must be guarded with more care, and performed with more force than the expiration. In one suffocating, the agony is in elevating the chest and drawing the breath. On the approach of death, the inspiration becomes more laboured, that is, the exterior muscles are in violent action; but the act of expiration is an interval of rest.

*Fourth.* These nerves, which govern the muscles of inspiration, are linked more intimately by sympathy with the state of circulation and respiration; for we see in disease, as in experiments on animals, that when the powers of life have run low, the sympathy is still exerted with such sudden catching of the muscles of inspiration, and with an effort so powerful and unexpected as to startle, while the expiration is soft and without effort. We perceive the same sympathy causing the same sudden and powerful inspirations, and marking the presence of life, when a person is recovering from fainting, or from suspended animation, from whatever cause; as drowning, hæmorrhage, &c. The sudden inspiration is always the first of the renewed actions of life, as it is the last in exhausted nature.

This corresponds with the experiments made on animals. When the sensibility is exhausted in the common spinal nerves, from the ebbing of life, the respiratory nerves on the neck and side of the chest are still capable of exciting the muscles to renewed vibrations; they are the last to die.

These considerations exhibit the importance of the act of inspiration over that of expiration, and prove the necessity for these exterior nerves of respiration.

We have seen by experiments, that the respiratory nerves are distinguished from the other nerves by retaining their power longer: that they are alive to impression, and can be made to produce convulsions in the muscles they supply, after the other nerves

are dead to the application of stimuli. In disease, during the oppression of the mental faculties, and on the approach of death, we witness these nerves, and the muscles put into operation by them, continuing their functions, when in other respects the body is dead. This circumstance, so familiar to the medical observer, might have led to the conclusion to which we have arrived, more laboriously, through anatomical investigations; that there are a great many muscles extended over the body, and which perform the common offices under the will, which are occasionally drawn into combination with the muscles of respiration, and are held in relation to the vital functions by a distinct system of nerves, and that these nerves have a centre and a source of power, different from that of the voluntary nerves.

## SOME FURTHER REMARKS ON THE PATHOLOGY OF THE RESPIRATORY SYSTEM OF NERVES.

When we survey the full extent of the respiratory system of nerves, we are prepared to comprehend its importance to the continuance of life. The infant born without a brain can breathe if the origins of these nerves be entire. Deep wounds of the brain, though eventually fatal, are not necessarily, or instantly so. The man wounded in the spine, below the origins of the nerves which we have traced, drags on existence for a few days ; but a bruise on the part of the *medulla oblongata*, from which these nerves take their departure, is death in the instant ; a breath is not drawn again.

In describing the effects of violence on the medulla oblongata, authors have attributed the sudden death to injury of the roots of the nerves of the par vagum ; and yet we have a statement from the same authority, that an animal will survive the division of both nerves of the par vagum. Now that we find that many respiratory nerves depart from the same centre, and go out to all the parts of the muscular

frame, which move in respiration, we can better comprehend, how injury of the medulla oblongata suppresses at once the act of respiration in the nostrils, throat, and windpipe, as well as the action of the muscles both without and within the chest; even the expression of the agony of dying is, by the injury of the roots of all these nerves, suddenly interrupted, and actual death follows quickly, owing to the cessation of the respiratory functions.

The first thing that strikes us is the vital character of these nerves, called respiratory; that as they form a system belonging to the heart, lungs, stomach, larynx, throat, and the whole exterior association of muscles of respiration, they must be essential to life, and influenced in all mortal affections; and that, in fact, death cannot take place whilst this division of the nervous system is unchanged or unaffected. On the contrary, the injury to their function is attended with immediate death, and the change takes place with appalling suddenness; not a breath is drawn, nor a word uttered, nor a struggle to indicate pain, nor a feature discomposed.

On the contrary, if other parts of the body are injured by disease or accident, death comes slowly from the rising of inflammation, or the extension of the influence slowly over the system; at length the respiratory system partakes of the influence, the chest rises higher and more frequently, an alarming symptom, when there is reason to fear approaching dissolution; the throat is then affected; the whole apparatus of respiration is violently agitated; the chest, neck, lips, and cheeks, and eyeballs are wrought with terrible convulsions; the breathing is about to stop; the action returns with sudden and startling effort, and then ceases, the patient dying in the state of expiration, the muscles of inspiration being incapable of renewing their effort.

If it be important to know the approach of danger, and to distinguish betwixt nervous agitation from the formidable symptoms of approaching dissolution, it

is necessary to know the causes of these symptoms, otherwise the physician is no better than the nurse.

It must happen that the derangement of one part of this class of important organs must affect the other. The stomach, for example, as the most abused in its office, is daily exhibiting the effect of its close alliance with this system of nerves; and what we learn from this anatomy of the respiratory system, is, that the stomach stands in close connection with the respiratory nerves, and that an irritation on the stomach will have all the effects of an injury immediate upon the lungs.

The stomach, heart, and lungs are undoubtedly the seat of that affection which is attended with sudden death; when there are no tokens or symptoms in the agitations of the respiratory organs, the source from which danger is to be most apprehended is the stomach; and founding on the fact expressed above, I have to suggest, that it is the duty of the patient to struggle against the increasing influence of the stomach on the condition of the respiratory organs: that the physician has not merely to regulate the stomach as the organs of digestion, but that the patient has to study to preserve his freedom of respiration against the prevailing influence of the stomach.

One of our athletæ out of training is pursy, breathless, and cannot bear the buffets, shocks, and falls to which he is liable in a bruising bout. But by spare and healthful diet, regular severe exercise, mimic combats, in which his breast, belly, and head are repeatedly buffeted, he is at length capable of standing under shocks that would be fatal to a man of equal strength and better constitution, but otherwise unprepared for what he is to undergo. Whether it be an effort of the body, or of the constitutional strength; whether it be an exertion of the head, or hands, or feet, we must come to the full exercise gradually and by slow degrees. Thus I argue the matter with a man whose palpitations are excessive and painful, on every accelerated step; he must not altogether avoid the occasion which gives him uneasiness, but by encounter-

ing them repeatedly, and by slow degrees, familiarize himself with the exertion.

As these nerves belong to a distinct system, and have a different origin from the nerves of sensibility and common muscular motion, so it is fair to presume that they will occasionally be affected by disease, when the others are left in a natural and healthy condition. But if the natural distinctions of the nerves be negligently considered, the affection of the respiratory nerves must remain obscured. I have already had occasion to remark, that the portio dura, or respiratory nerve of the face, is very subject to derangement, producing partial paralysis, or frequent and spasmodic twitchings of the face. The most frequent defect proceeding from this cause is a rapid and twinkling motion of the eyelid of one side. Sometimes we find the whole of one side of the face subject to contractions, by which the features are drawn towards the ear. This condition of nerves, and consequent spasmodic muscular contractions, sometimes extends to the neck; then we see the head suddenly twitched sideways, at the same moment that the mouth is drawn aside. This is a great deformity; for while the individual is animated and speaking with exertion, he gives those sudden startling motions, opening his mouth and turning it to his shoulder, as if he were catching flies. The neck is twisted, the head bent down, and the mouth turned laterally and opened. These motions must now be attributed to the influence of the respiratory nerves of the face and neck.

But the same class of nerves, in their distribution to the chest, are subject to the same derangement. It is not very uncommon to find the shoulder of a young person falling low, and the appearance of distortion produced by a paralysis of that part of the trapezius muscle which supports the shoulder, and which is supplied by the spinal accessory nerve. This affection forms a parallel with the paralysis of the eyelid and the cheek; and there are not wanting examples of spasmodic affection of the thorax resembling those

which I have just noticed on the side of the face and neck.

We perceive that these nerves of respiration, so peculiar in relation and function, are differently influenced by disease from the other division of the nervous system. We know that their functions are left entire when the voluntary nerves have ceased to act, and they are sometimes strangely disordered, while the mind is entire in all its offices, and the voluntary operations perfect. In tetanus the voluntary nerves are under influence, and the voluntary motions locked up in convulsions; in hydrophobia, on the contrary, the respiratory system is affected; and hence the convulsions of the throat, the paroxysms of suffocation, the speechless agony, and the excess of expression in the whole frame, while the voluntary motions are free.

The confusion between vital and voluntary nerves, the combining the par vagum and sympathetic nerves together, and the exclusion of the *portio dura* of the seventh nerve, the spinal accessory nerve, and the external thoracic nerve, from their natural classification with the diaphragmatic or phrenic, has given rise to very vague theories, and occasioned very inaccurate statements of pathological facts.

The frequency of sudden death, where no corresponding appearances are exhibited in the brain or heart, leads us to consider more attentively the only part of the system through which life can be directly extinguished. In *angina pectoris*, we witness the agony of suffering in this system when the patient survives; and when he dies suddenly, we can imagine it to proceed from an influence extending over these nerves, and interrupting the vital operations. We have seen that a branch of this system may suddenly cease to operate on the corresponding muscles, and that in this way the side of the face may be deprived of all participation in the act of respiration, and all expression be lost. What would result from a more universal defect

in the actions of this class of nerves, but sudden death?

The stomach, supplied with the great central nerve of this system, exhibits the most powerful influence on these extended nerves; a blow on the stomach "doubles up" the bruiser, and occasions that gasping and crowing which sufficiently indicates the course of the injury: a little more severe, and the blow is instantly fatal. A man broken on the wheel suffers dreadful blows, and his bones are broken, but life endures; the *coup de grâce* is the blow on the stomach.

The position of the asthmatic shows how this system is affected; whether directly or indirectly, it is not our present business to enquire. He stands stooping forward, resting his arms so as to throw the muscles of the chest into operation upon the ribs. The position of the head and the rigidity of the muscles of the neck, the action of the mastoid muscle, and of the cutaneous muscle, visible in the retraction of the cheeks and mouth, and the inflation of the nostrils, carry us back in review of the nerves and muscles of respiration.

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It will now, perhaps, be acknowledged, that the methods of physiologists, in accounting for the combination of parts in the actions of respiration, were very imperfect, or rather altogether erroneous. To account for the convulsion of the diaphragm in sneezing, they were constrained to go a far way about: first, connecting the roots of the phrenic with the sympathetic nerve: bestowing sensibility on the latter, which it does not possess: then, following a remote connection between it and the nerves of the nose; then again, counting the relations between the facial nerve and the third of the neck: they satisfied themselves that they had explained the manner in which the diaphragm became convulsed upon ir-

ritating the membrane of the nose. Another misconception was engrafted on the first; they spoke of these actions as convulsive and irregular, which are amongst the most admirable provisions for the protection of life. As to the act of sneezing, like coughing, it is a consequence of an irritation of the extremity of one of the respiratory nerves, whence the whole muscles of respiration are brought into action. That there is nothing accidental, nor of the nature of convulsion, is shown by the admirable adjustment of the muscles to the object. A body irritating the glottis will call into simultaneous action the muscles of respiration, so as to throw out the air with a force capable of removing the offending body. But if the irritation be on the membrane of the nose, the stream of air is directed differently, and, by the action of sneezing, the irritating particles are removed from these surfaces. By the consideration of how many little muscles require adjustment to produce this change in the direction of the stream of air, we may know, that the action is instinctive, ordered with the utmost accuracy, and very different from convulsion.

### OF SMELLING, AS INFLUENCED BY THE PORTIO DURA OF THE SEVENTH NERVE.

It will, I hope, be acknowledged that I have studied the functions of the parts to which the nerves are sent, before I made my experiments or drew my conclusions. Even in the exercise of the sense of smelling, parts are employed, which do not, at first, seem necessary. For the highest enjoyment or exercise of the sense of smelling, it is necessary that the stream of air inhaled through the nostrils should change its direction, and be increased in force. In breathing through the nose, the air is carried directly backward. If the nostrils are expanded in anxious or hurried respiration, the passage is enlarged, and made more direct. But, perhaps, my reader is not aware that in each nostril there are two circular

openings, the innermost something more than half an inch within the other. This interior circle expands, and becomes lower when the breath is forcibly drawn into the lungs; but in the act of smelling it is much diminished and elevated. The change in the form and relation of the exterior and internal nostril is performed by the action of the muscles on the cartilages; and the effect of the change is to increase the force of the stream of air, and to direct it up towards the seat of the sense of smelling. In common breathing some part of the effluvia afloat in the atmosphere reaches the seat of the sense; but fully to exercise the sense, it is necessary to concentrate and direct the stream of air, as I have described.

It will now be comprehended how the destruction of the *portio dura*, or respiratory nerve of the face, affects the organ of smelling; for if by the injury of that nerve the motion of the muscles of the nostrils be lost, the breath may be drawn into the lungs through the relaxed passage, but it will not be drawn forcibly up towards the seat of the olfactory nerve, nor will the air brush over the surface on which the proper nerve of sense is expanded.

A man being paralytic on one side of the face by the loss of power in the *portio dura*, he was made to smell ammonia: it did not affect the paralytic side, because it was forcibly inhaled into the cells of the nose only on the side where the nostril was movable. On trying the experiment on a dog, in whom the *portio dura* of one side had been cut, the same thing was manifested; he snuffed it up with the sound side, and showed the natural consequence of the irritation of the membrane; while he was not similarly affected when the bottle was put to the paralytic nostril.

Unless I had attended to the structure and function of the part, on witnessing these phenomena, I might have conceived that the seventh nerve was the nerve of smelling, like a noted French physiologist, who concluded too hastily, that he had discover-

ed the nerve of vision and of smelling in the fifth nerve.

I allude to certain experiments lately performed in London by a distinguished visitor, which afford a proof of the utter impossibility of reasoning correctly on these subjects without the knowledge of the anatomy. The olfactory nerve was destroyed, and ammonia put to the nostrils of the animal, and when the creature sneezed it was a *coup de théâtre!* then the gentlemen congratulated themselves that it was discovered that the first pair of nerves was of no use!! The common irritability of the schneiderian membrane results from the fifth nerve: why does the membrane possess this sensibility, and why is the sensibility joined to the actions of the respiratory system? because these passages must be guarded as the larynx is guarded. When any thing offensive is lodged there, it must be removed, and the means nature employs is to drive the air by an instinctive action of the respiratory organs, violently and suddenly, through the nostrils. But what has this to do with smelling? As well might we destroy the olfactory nerve, and wonder that the creature experimented on still coughed when the larynx was tickled.

We have some observations on this subject in Mr. Shaw's paper already quoted. "The effect upon the nostril is the most obvious symptom, when the nerve is cut in the ass. If after having cut the right nerve (*portio dura*), we hold the nostril for a short time, so as to prevent the animal from breathing, he will, when freed, begin to snort, but with the left nostril only. If we hold carbonate of ammonia to the paralysed nostril, he will not be affected; but if it be held to the other, he will snuff it up, and then curl the nostril, and have an expression in the whole of that side of the face, as if he were going to sneeze, while the right side will remain quite unmoved."

The rationale of this is worth attention; by the neglect of it some physiologists and experimenters have appeared to much disadvantage.

The act of smelling is not simply the act of drawing the breath; but while the breath is drawn there is a conformity in the motion of the nostrils, by which the air, loaded with the effluvia, is directed to the seat of the olfactory nerve; that is to say, is made to circulate in the higher parts of the cavities of the nose, instead of streaming directly backwards into the posterior nostrils. This was the reason why, on putting the ammonia to the nostril which was still, the creature was not excited, although there had been nothing done to injure the sensibility of that side of the nose. If a man were simply to draw his breath in taking snuff, the powder would be drawn into his fauces and lungs; but to snuff, the point of the nose is drawn down, and the nostrils contracted, and then when the air is inhaled, the snuff rises to the superior cells, and stimulates all the interior of the nostrils. Although by this stimulus he sneezes, the olfactory nerve has nothing to do with it. The luxury is in the stimulus of the respiratory system through the excitement of the membrane, not in the odour as enjoyed by the olfactory nerve. The sensitive branches of the fifth are first excited, then the respiratory system is in a secondary manner affected; and to ascertain whether the mode of communication between the fifth and the respiratory nerves be affected at their roots in the brain, or at their extremities, is a fair question to be determined by experiment or reasoning.

## THESE RESPIRATORY NERVES ARE ORGANS OF EXPRESSION.

We may notice another office of these respiratory nerves; in smiling, laughing, and weeping, the influence is solely propagated through them. The face, we have seen, is dead to all changes of the kind when the nerve of this class which goes to it is destroyed, whether it be by division of the nerve, or from its being surrounded with inflammation or suppuration. When we consider that all the respiratory nerves de-

part from the same source, and participate in the same functions; and more especially when we see the respiratory organs so very distinctly affected in the conditions of the mind, which give rise to these affections, it is not too much to suppose, that what is proved in regard to one of these nerves, is true of the whole class, and that they alone are influenced in laughter. Physiologists who have not investigated the cause, are yet agreed in describing laughter to be a condition of the respiratory muscles, where the air is drawn in rapidly, and thrown out in short spasmodic motions of these muscles; that crying is nearly the reverse, the inspiration being cut by spasmodic actions of the muscles of inspiration. By these considerations are explained the *subrisus* which arises from abdominal irritation, and the sardonic retraction of the muscles of the face produced by wounds of vital parts, and particularly of the diaphragm. It explains also the successive convulsive lifting of the shoulders in wounds of the diaphragm.

That a system of nerves so intimately combined as this is with the other parts of the general system, should suffer in hysterical disorders, cannot surprise us; and admitting that irritation reaches to the respiratory system, we may perceive how rapidly the change may be produced, from the convulsions of laughter to those of crying; and where, if there be a corresponding condition of the mind, it rather follows than precedes the expression of the frame.

It would have been extraordinary if we had arrived at any satisfactory theory of expression, before it was known through what instruments the mind influenced the body, during emotion or passion. But since we know that the division of the respiratory nerve of the face, deprives an animal of all expression; and that the expressive smile of the human face is lost by an injury of this nerve: since it is equally apparent, that the convulsions of laughter arise from an influence extended over this class of nerves, it comes to be in some sort a duty, in pur-

suing this matter, to examine farther into the subject of expression. We may be at the same time assured of this, that whatever serves to explain the constant and natural operations of the frame, will also exhibit to us the symptoms of disease with more precision.

In terror, we can readily conceive, why a man stands with eyes intently fixed on the object of his fears: the eyebrows elevated, and the eyeballs largely uncovered; or why, with hesitating and bewildered steps, his eyes are rapidly and wildly in search of something. In this we only perceive the intent application of his mind to the objects of his apprehensions, and its direct influence on the outward organs. But when we observe him farther, there is a spasm on his breast: he cannot breathe freely: the chest remains elevated, and his respiration is short and rapid: there is a gasping and convulsive motion of his lips: a tremor on his hollow cheeks: a gulping and catching of his throat: his heart knocks at his ribs, while yet there is no force in the circulation, the lips and cheeks being ashy pale.

It is obvious, that there is here a reflected influence in operation. The language and sentiments of every people have pointed to the heart, as the seat of passion, and every individual must have felt its truth. For though the heart be not in the proper sense the seat of passion, it is influenced by the conditions of the mind, and from thence its influence is extended through the respiratory organs, so as to mount to the throat, and lips, and cheeks, and account for every movement in passion, which is not explained by the direct influence of the mind upon the features.

So we shall find, if we attend to the expression of grief, that the same phenomena are presented; and we may catalogue them, as it were, anatomically. Imagine the overwhelming influence of grief — the object in the mind has absorbed the powers of the frame; the body is no more regarded, the spirits have left it; it reclines, and the limbs gravitate, the

whole body is nerveless and relaxed, and the person scarcely breathes; so far there is no difficulty in comprehending the effect in the cause. But why, at intervals, is there a long drawn sigh, why are the neck and throat convulsed, and whence the quivering and swelling of the lip, why the deadly paleness, and the surface earthy cold; or why does convulsion spread over the frame like a paroxysm of suffocation?

To those I address, it is unnecessary to go farther, than to indicate that the nerves treated of in these papers are the instruments of expression, from the smile upon the infant's cheek to the last agony of life. It is when the strong man is subdued by this mysterious influence of soul on body, and when the passions may be truly said to tear the breast, that we have the most afflicting picture of human frailty; and the most unequivocal proof, that it is the order of functions which we have been considering that is then affected. In the first struggles of the infant to draw breath, in the man recovering from a state of suffocation, and in the agony of passion, when the breast labours from the influence at the heart, the same system of parts is affected, the same nerves, the same muscles, and the symptoms or characters have a strict resemblance.

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Having examined the system of nerves and muscles, which are the agents in respiration, in their fullest extent and in all their bearings: having looked at them in their highest state of complication in the human body, and having traced them upwards, from the animals of simple structure, and then by experiment, and in a manner analytically as well as synthetically, their relations become obvious. Instead of one respiratory nerve, the *par vagum*, the nerve so called, is found to be the central one of a system of nerves of great extent. Instead of the relations of the vital organs of circulation and respiration de-

pending on some supposed influence of the sympathetic nerve, they are found to have an appropriate system.

This system of nerves, extricated from the seeming confusion in which it lay hitherto encumbered, is found to be superadded to that of mere feeling and agency, attributes common to all animals: through it we see, engrafted as it were, and superadded to the original nature, higher powers of agency, corresponding to our condition of mental superiority: these are not the organs of breathing merely, but of natural and articulate language also, and adapted to the expression of sentiment, in the workings of the countenance and of the breast, that is, by signs, as well as by words. So that the breast becomes the organ of the passions, and bears the same relation to the developement of sentiments, as the organs of the senses do to the ideas of sense.

### OF THE NINTH PAIR; LINGUALIS, OR HYPOGLOSSUS.

This nerve arises by a number of filaments coming off in regular succession from the medulla oblongata, and from the side of the corpus pyramidale, and betwixt that body and the corpus olivare. These filaments collecting in the direction of the condyle of the occipital bone, pass out from the skull by the anterior condyloid foramen; when it has made its exit, this nerve adheres to the eighth pair, by cellular filaments *, and from that part of the eighth nerve where it gives off the laryngeal branch, there comes off a communication to the ninth nerve. It receives also branches from the first cervical nerve, or from the branch of union of the first and second cervical nerves. Here it is also joined by a twig from the sympathetic nerve. When dissecting in the neck,

* Some affirm that there is a connection by filaments of nerves at this junction of the 8th and 9th :—" etiam interdum tradita acceptave fibrilla nervea." Scarpa, Tab. I. so Asch. Fallopius.

we find the ninth nerve lying by the side of the internal jugular vein under the stylo-hyoideus muscle, and under the sub-maxillary gland, and near the horn of the os hyoides.

The nerve making a curve to ascend again to the tongue, gives off that branch which is called the DESCENDENS NONI. The continued trunk of the nerve passes before the external carotid artery, and forwards under the larger branches of veins. It lies parallel to the lingual artery, but not so deep, and on a higher level. Here it turns upwards under the stylo-hyoideus and digastricus muscles, and betwixt the stylo-glossus and hyo-glossus. Where the nerve is near the os hyoides, and passing under the hyo-glossus muscle, it sends down a twig which passes to the thyreo-hyoideus muscle.

The continued nerve goes under the mylo-hyoideus and is liberally distributed to the muscles of the tongue, but not before these branches have formed a sort of plexus. It terminates by numerous filaments, which form a net-work amongst the muscles of the tongue; to which is united part of that branch of the fifth pair which goes to the tongue. *

The RAMUS DESCENDENS NONI comes off from the lower edge of the ninth nerve, (the origin is covered by the internal jugular vein, and by the occipital artery.) This branch, near its origin, is connected with the par vagum; it then passes downward, obliquely over the sheath of the carotid artery, and under the thyroid vein. In the superficial dissection of the muscles of the neck, two slender twigs of nerves will be seen to come from the side of the neck, and crossing the jugular vein, unite to this descending branch of the ninth. Those twigs come from the second and third cervical nerves, (in some instances those twigs are found to be derived from the first orgin of the phrenic nerve); and a plexus is formed by their union with the descendens noni, viz. the super-

* This has been called *plexus cerato-basio-stylo-glossus!*

ficial cervical plexus. From this centre are sent out many delicate and superficial nerves to the omo-hyoideus, sterno-thyroideus, and sterno-hyoideus muscles; and a branch of the descendens noni takes a course along the central tendon of the omo-hyoideus, to supply the lower division of this muscle. There is a branch of some interest, although small and deep, among so many greater nerves; it comes from the par vagum, and the descending branch of the ninth, and joins this cervical plexus, where it may be traced piercing the scalenus muscle.

Thus we find that the ninth nerve has connections with the eighth pair of nerves, with the spinal accessory, the sympathetic, the cervical, and phrenic nerves. When this nerve is injured, the motion of the tongue is lost, but the sense of taste remains unimpaired. On the contrary, when the branch of the fifth nerve going to the tongue is hurt, the sense of taste is lost, while the mobility of the tongue remains.* Columbus knew a man who had no sense of taste, and who ate indifferently every thing presented to him. When he died, Columbus was curious to know the cause of this, and he found that he altogether wanted the gustatory nerve or lingual branch of the inferior maxillary nerve. Cases detailed by Professor Scarpa still further illustrate this fact. A woman subject to epipleptic attacks in an early age, was seized in her pregnancy with an hemiplegia and loss of speech. From this attack, by the use of medicines, she recovered; but in a future labour the disease recurred. Now the cure was less complete: for, though she regained the use of her arms, she never recovered the faculty of speech, or was only capable of articulating with great dissonance the monosyllables, affirming or denying. Upon making her exert herself to speak, they observed no motion in the tongue; and, upon applying the hand under the jaw, they could feel no motion in the mus-

* Soemmerring de Cerebro et Nervis.

cles of the tongue; yet she relished her food and drink, and had an acute sense of taste, and could swallow easily. He mentions another case, where the patient was attacked with a sense of weight at the root of the tongue, a difficulty of speaking, and copious flow of saliva. In a short time he entirely lost the power of articulating, but retained acutely the sense of taste. *

### OF THE CERVICAL NERVES.

We have now done with the more irregular nerves of the head, and now we come to the spinal nerves, which all agree in structure and function, being double at their roots; and having one root given to bestow sensibility, and the other root to bestow motion.

First cervical nerve. Tenth pair of the skull. Sub-occipital nerve. — This is the least of all the nerves of the spine; it arises by two roots from the medulla spinalis. Some difference has been observed in the manner in which those roots collect their filaments; and only the anterior root or fasciculus is described by some authors. The posterior fasciculus is, indeed, the larger, and comes in a direction different from the general direction of the roots of the other cervical nerves. The roots of the sub-occipital nerve are connected with the spinal accessory nerve, so as to give rise to some difference of opinion, and sometimes they form a union with the posterior roots of the second cervical nerve. The fibres of the sub-occipital nerve passing transversely, and a little obliquely upwards, go out under the vertebral artery, and betwixt it and the first vertebra of the neck. The little trunk of the sub-occipital nerve, thus formed, swells into a kind of ganglion, and having escaped from the spine, rises for a little way upwards, and then divides into two branches.

* Tabulæ Neurologicæ, Auctore Anton. Scarpa.

It has long been the author's intention to prosecute the subject of the nerves of the tongue, and he hopes in the succeeding season to accomplish it.

The anterior of these branches is the smaller. It passes down upon the inside of the vertebral artery; its filaments unite with the hypo-glossal nerve, or ninth pair, and with the superior cervical ganglion of the sympathetic, and with the first branch of the second cervical nerve.* The larger and posterior branch divides into eight twigs, which are chiefly distributed to the muscles moving the head — to the obliquus superior and inferior, the recti postici and laterales, complexus, and splenius. Some of those muscular branches unite with that branch of the second cervical nerve which ascends upon the occiput.

Second cervical nerve. — This nerve, arising by a double origin from the spinal marrow, like the other nerves of the spine, passes betwixt the first and second vertebræ. It is larger than the last, and divides into two branches.

The superior branch sends up a considerable division behind the projection of the transverse process of the first vertebra, to be united to the sub-occipital or first cervical nerve. Several twigs pass forward to unite with the superior cervical ganglion of the sympathetic nerve, and with some of the more anterior branches of the third cervical nerve, and with the ninth and spinal accessory nerves. Besides these intricate connections, irregular branches of this nerve proceed to the small muscles, moving the head, and lying on the fore part of the spine. The *posterior* branch of the second pair of cervical nerves is chiefly a muscular nerve. It rises up by the side of the complexus, gives branches to that muscle and to the splenius, and communicates with the branches of the first cervical. Its branches are also distributed to the upper part of the trapezius muscle, from which they extend along the integuments, covering the occiput even to the summit of the head.

The third cervical nerve, in the first place,

* A very small nerve is described by some authors as passing from the anterior division of this nerve, into the canal of the vertebral artery.

communicates with the second and fourth cervical nerves, then forwards with the sympathetic and lingual nerves. It sends down a twig to unite with the origin of the phrenic nerve from the fourth cervical nerve. From the anterior division of the third cervical nerve, branches pass to the splenius and complexus, and trapezius, and upwards to the ear. We may observe also a cutaneous nerve which accompanies the external jugular vein, viz. NERVUS SUPERFICIALIS COLLI; the distribution of which is chiefly to the angle and margin of the lower jaw, while some of its branches enter the parotid gland, and unite with the extremities of the portio dura and other facial nerves. *

The SMALL POSTERIOR DIVISION of the nerve passes to the complexus, spinalis cervicis, and multifidus spinæ, while at the same time it unites to the branches of the second cervical nerve.

The FOURTH CERVICAL NERVE, coming out from betwixt the third and fourth cervical vertebræ, divides into its anterior and posterior branches like the other cervical nerves. The first goes to form, with the third and fifth cervical nerves, the PHRENIC NERVE. It sends also forward a branch to the symphathetic, and also to the integuments of the neck and shoulder, and to the supra and infra spinatus muscles. These are called by Soemmerring SUPERCLAVICULARES ANTERIORES, MEDII, and POSTERIORES. And to these is attributed the false pains when the diaphragm is irritated. These too in all probability cause the convulsions of the shoulder when the diaphragm is wounded.

The great POSTERIOR DIVISION of the fourth cervical nerve passes to the muscles of the spine and shoulder, in conjunction with the branches of the third cervical nerve.

FIFTH CERVICAL NERVE. — This nerve comes of course from betwixt the fourth and fifth vertebræ,

* This nerve continues to give sensibility to the lower part of the face, after the branches of the 5th are cut.

and from betwixt the scaleni muscles. It divides also into two branches. The SUPERIOR of these passes backwards to the muscles of the back and shoulder; and a branch formed by it, and the sixth passes down under the scapula and serratus major.

This last is the nerve I have described under the term EXTERNAL RESPIRATORY NERVE. It has the same, source with the phrenic nerve; it is connected with that internal nerve; at its origin it is separated from the phrenic by a very small portion of the scalenus. Its course is through the axilla, passing deep under the nerves of the arm, and unconnected with the axillary plexus; it is distributed to the muscles on the side of the chest, and combines them into a class with the internal respiratory muscles. The superior division of the nerve sends up also two small twigs of communication with the fourth cervical nerve.

The INFERIOR DIVISION of the fifth cervical nerve sends down upon the side of the neck a considerable branch to the formation of the phrenic nerve. It communicates with the root of the sixth nerve, and sends muscular branches backward.

The SIXTH CERVICAL NERVE. — The muscular branches of this nerve are large, and extensive in their course. They pass into the levator scapulæ, extend under the trapezius, and unite with the extreme branches of the spinal accessory nerve. They are prolonged to the latissimus dorsi and serratus magnus. Branches also extend down behind the clavicle, and under the pectoral muscle.

Besides these branches, this nerve communicates with the fifth, and gives out an origin to the phrenic nerve; and lastly, uniting to the seventh, it passes into the axillary plexus.

The SEVENTH CERVICAL NERVE. — This nerve goes almost entirely to form the axillary plexus. There is a communicating nerve from the last of this, and from that communicating branch generally there passes off a filament to the phrenic nerve; and from the very root of the nerve there passes off a branch to

the lower cervical ganglion of the sympathetic.* Irregular twigs also descend from this nerve under the clavicle to the pectoralis minor and major.

The EIGHTH CERVICAL NERVE. — The greater part of this nerve passes to the axillary plexus. It sends small branches to the lower cervical ganglion of the sympathetic, and to the muscles of the breast; which last descend behind the clavicle.

### RECAPITULATION OF THE DISTRIBUTION OF THE CERVICAL NERVES.

Upon reviewing the description of these nerves, we find that the general tendency of their branches is backwards over the side of the neck, to the muscles moving the head and shoulders. We find also that they are connected in a very intricate manner with the most important nerves of the cranium. High in the neck and under the jaw, they are connected with the portio dura, with the fifth pair, with the eighth and ninth pairs, and with the sympathetic. Towards the middle of the neck they are still throwing their connecting branches to the descendens noni, and sympathetic, and eighth pair. The lower cervical nerves again are still supplying the connections with the lower ganglion of the sympathetic.

Further, we find that the phrenic nerve is derived principally from the third and fourth, and branch of communication betwixt the fourth and fifth. The inferior external respiratory nerve is derived principally from the fifth cervical nerve, and also has communicating branches with the fourth and sixth. The AXILLARY PLEXUS is formed by the fifth, sixth, seventh, and eighth cervical nerves, and first of the back.

* These communications betwixt the cervical nerves, and the sympathetic nerve, are, I believe, branches of the sympathetic running down upon the arms.

## OF THE DORSAL NERVES.

There are twelve dorsal nerves. These, like all the other spinal nerves, are formed by two fasciculi of fibres ; one from the fore, and the other from the back part of the spinal marrow. These filaments run for some way superficially in the length of the spinal marrow before they pierce the dura mater. They pierce it separately; the posterior root first forms a ganglion, and then the two fasciculi are united. They are now betwixt the heads of the ribs. We must here recollect, that the trunk of the sympathetic nerve, which passes along the thorax, runs down behind the pleura, and before the heads of the ribs through all the length of the back. It receives, as it passes, the interstices of the several ribs, at each interval a communicating nerve from the spinal marrow, that is, an additional root is afforded by each nerve as it passes; it is in a manner thus made up of roots, from the intercostal nerves, hence the sympathetic is sometimes called *intercostal.*

The intercostal nerve, properly so called, sends its greater branch forwards betwixt the ribs; some lesser branches pierce backwards to the muscles of the back; opposite to this there goes out from each nerve the first branch of union with the sympathetic, and on this union a ganglion is formed. Sometimes there run out in this direction two short branches from the spinal nerve, to unite with the ganglion of the sympathetic ; but more commonly there passes in a retrograde direction from the intercostal nerve, where it is about to take its course between the ribs, another branch of communication which joins the sympathetic.

The intercostal nerves pass on betwixt the ribs, and under the protection of the groove on the lower edge of the rib, in company with the intercostal arteries, and reach even to the sternum. In this course they supply the intercostal muscles and triangularis sterni,

while they are at the same time sending out branches, which, piercing the intercostal muscles and fascia of the thorax, are distributed to the muscles on the outside of the chest. — Those branches which we mentioned as passing betwixt the heads of the ribs, and which are sent off immediately upon the trunk escaping from the vertebral opening, supply the multifidus spinæ and levatores costarum, and other extensor muscles of the spine. Slips proceeding from the second, third, fourth, and fifth intercostal nerves, send branches to the pectoral muscles, the serratus anticus, and serratus posticus superior, trapezius, and rhomboideus. The sixth, and all the lower nerves of the back, send branches from betwixt the ribs to the latissimus dorsi, serratus inferior, and abdominal muscles. The eleventh and twelfth are distributed to the diaphragm, quadratus lumborum, psoas magnus, and iliacus internus.

### LUMBAR NERVES.

The lumbar nerves are five in number. They arise like the other spinal nerves. The first comes out under the first lumbar vertebra, and the others in succession. Their trunks are covered by the psoas magnus. They pass very obliquely downward, and the three lowest are of remarkable size.

In the general distribution, we may first remark the posterior branches, which go backwards to the muscles which support and extend the spine. Again, the anterior branches; which give, 1st, additional branches to the sympathetic nerve as it passes over the vertebræ of the loins, and by which it is supported and reinforced till it terminates in the pelvis; 2dly, they have frequent connection with each other, and with the last nerve of the back, and first of the sacrum; 3dly, they send out branches, delicate but of great extent, to the muscles of the loins and back, and to the abdominal muscles and integuments of the groin and scrotum; 4thly, the principal anterior branches of the lumbar nerves pass down to form

(along with the great nerves of the sacrum) the anterior crural nerve, the obturator, and the great ischiatic nerve.

### SACRAL NERVES.

The nerves which come out from the extremity of the medulla spinalis, or cauda equina, through the sacrum, are in general five in number. Sometimes there is one more or less. The first division of each sacral nerve is into those branches which pass out by the posterior foramina of the sacrum, and those which, by the anterior foramina, come into the pelvis. The posterior branches are very small, and pass to the muscles supporting the spine; while the anterior ones are particularly large, especially the first and second, which, with the lowest of the loins, go to form the largest nerve of the body, the ischiatic nerve.

It is difficult to recollect the distribution of the several branches of the lumbar and sacral nerves, when taken thus together; but when we deliver the description of the nerves of the thigh and leg, we count them, and remember them with comparative ease. At present we are best prepared to follow the sympathetic nerve in its course.

### OF THE GREAT SYMPATHETIC NERVE; OR, INTERCOSTAL NERVE.

The nerve called *sympathetic* is, in fact, an entire system of nerves, which distributed most evidently to the viscera of the thorax, abdomen, and pelvis, does in fact extend universally, by joining the other nerves of the head and extremities. But in this extended distribution it is lost by joining other nerves. While in the abdomen and thorax it is particularly distinct and demonstrable. The old method of describing the sympathetic nerve is to consider it as derived from the sixth and fifth, for they had no idea of a nerve but as a tube coming from the brain; for

the sake of clearness we shall still describe it as thus descending.

The sympathetic nerve is in general considered as originally derived from the sixth pair; it also takes its origin from the first or ophthalmic division of the fifth pair, and from the Vidian branch of the fifth pair. It appears without the skull, sometimes behind and sometimes before the carotid artery, and sometimes it is double in its exit from the base of the skull. Almost immediately after it has escaped from the skull, it forms its first ganglion; which is very large and remarkable, and has the name of the SUPERIOR CERVICAL GANGLION of the sympathetic nerve. It is of a soft consistence and reddish colour, and it extends from the skull to the transverse process of the third vertebra. It gradually tapers downwards until it becomes a very slender nerve. This ganglion has much variety of shape in different subjects, and may be said in general to receive twigs of nerves upon the back part; whilst it gives them out upon the fore part.

The superior cervical ganglion of the sympathetic nerve receives nerves from the second, third, and fourth cervical nerves, and even sometimes from the root of the phrenic nerve. It has also connections with the hypo-glossal, par vagum, and glosso-pharyngeal nerves. It sends out branches to unite with the glosso-pharyngeal, and which follow that nerve in its distribution to the tongue and pharynx. Many of its branches surrounding the carotid artery form connections with the internal and external laryngeal nerves and proceed in meshes, or form plexus along with the branches of the artery. These may be followed to great minuteness.

To be more particular in the description of these anterior branches of the sympathetic nerve, they are called the NERVI MOLLES, or NERVI VASORUM. They are nerves peculiarly soft, with a greater proportion of cellular membrane; they spread in net-works along the arteries, and form frequent connections by

little knots like small ganglions. Classed with these nervi vasorum, are branches which pass forward from the upper ganglion of the sympathetic, to unite with filaments from the internal laryngeal nerve of the par vagum, and which form the external laryngeal nerve. It is remarked, that none of these branches of the sympathetic nerve are distributed to the larynx and pharynx without being mingled and associated with the glosso-pharyngeal nerve, or with the pharyngeal branch of the par vagum. * Of the nervi molles some form a plexus upon the internal carotid artery. These are extremely soft and pulpy, and are united with branches which descend from the glosso-pharyngeal nerve. A net-work is also formed, which covers the beginning of the external carotid artery. From this, as from a centre, branches are sent out with the arteries to the neck, and face, and glands under the jaw; and these last, with a mesh which passes up upon the temporal artery, unite with the portio dura of the seventh pair.

It has been often observed, that the branches of the carotid artery have a peculiar provision of nerves, and that these nerves are more numerous and minutely distributed than in any other part of the body. There are indeed no nerves in any part of the body which have so extensive and intricate connections with important vital nerves as the cutaneous nerves of the face and neck.

This distribution of the nerves has been considered a provision for that power possessed by the imagination, or rather that uncontrolable connection which exists betwixt the feelings and the action of the vessels in blushing, and in the expression of the passions. But I have proved this to be altogether false, since by cutting the portio dura of the seventh I have taken all expression from the face. The emotions visible in the countenance are, therefore, not attributable to the sympathetic nerve, and its nervi molles.

* Scarpa.

The lowest of the nervi vasorum or molles, sent off from the superior ganglion of the sympathetic nerve, descends in the course of the trunk of the nerve, and forms, with other branches, the superior cardiac nerve.

This nerve, generally called NERVUS CORDIS SUPERFICIALIS, passing down in the direction of the trunk of the sympathetic nerve, and near the longus colli muscle, is for some length a very slender branch; but in its course it receives two, three, or four additional twigs from the sympathetic, and branches which come under the carotid artery from the pharyngeal nerves. When this superior cardiac nerve is within an inch or two of the subclavian artery, branches of union pass betwixt it and the recurrent nerve of the par vagum; and branches of the nerves passing to the heart from the lower cervical ganglion, also join it. It then, attaching itself to the investing membranes and sheaths of the carotid and subclavian arteries, forms with others, a plexus of nerves, which run along the great vessels to the heart.

The continued trunk of the sympathetic, where it emerges from the superior cervical ganglion, is extremely small. It descends behind the carotid artery, and lies near to the spine.* When opposite to the fifth and sixth cervical vertebræ, the inferior cervical ganglion of the sympathetic is formed. In this course, twigs of communication pass betwixt it and the cervical nerves, or join it with the beginning of the phrenic nerve.

But not unfrequently on the left side, there are three cervical ganglions formed by the sympathetic nerve; the superior, middle, and inferior ganglions: or it happens that we find the sympathetic nerve split into two branches in the neck; one of which forms the middle, and the other the lower ganglion.

* It is to be observed, that in the horse and the ass, the sympathetic and the par vagum are incorporated in one sheath.

In the neck of the bird, the sympathetic is lodged within the canal for the vertebral artery.

There are received by the MIDDLE CERVICAL GANGLION or, THYROID GANGLION, branches of nerves, from the third, fourth, fifth, and sixth cervical nerves, and also sometimes from the phrenic nerve. The ganglion is by no means constantly found, and it is irregular in its size and shape. When large, and in what may be considered as its more perfect state, it gives off some considerable branches. Of these, part unite with the superior cardiac nerve already mentioned; others form the great or deep cardiac nerve, while lesser ones play round the subclavian artery, and unite with the lower cervical ganglion, or the upper thoracic ganglion.

The deeper cardiac branch of the sympathetic, splitting and again uniting so as to form rings, runs outwards, attached to the arteria innominata and arch of the aorta, to the heart. In this course, while it passes before the trachea, it forms connections with the recurrent branch and trunk of the par vagum. Under the arch of the aorta, we find this branch concentrated to form the GANGLION CARDIACUM of Wrisberg, or GANGLION MOLLE et PELLUCIDUM of Scarpa. This ganglion is like a mere enlargement or swelling of the nerve. From this, four or five branches may be enumerated; 1st, A branch passing behind the pulmonary artery to the back of the heart, and following the left coronary artery; 2dly, A small division to the anterior pulmonary plexus of the par vagum; 3dly, A pretty considerable branch which, passing behind the aorta, and betwixt it and the pulmonary artery, is distributed with the right coronary artery to the anterior part of the heart. On the left side of the neck, the sympathetic, receiving on the one side branches from the cervical nerves, and on the other giving off branches, which descend behind the carotid artery to the heart, (viz. the superior cardiac,) often splits before it forms the middle or thyroid ganglion, and sometimes throws its branches over the thyroid artery, and the ganglion lies upon that artery. Again, from the

ganglion there descend two series of numerous lesser filaments, which form meshes upon the thyroid and subclavian arteries to the heart. Others proceed downward behind the arteries to the lower cervical ganglion. Those branches which descend upon the arteries, intangle the roots of the thyroid, transversalis colli, and internal mammary arteries, in their plexus; these uniting, follow the subclavian artery, and form again a plexus upon the arch of the aorta. This is joined by branches from the par vagum and recurrent. The principal branches of this plexus terminate in the cardiac ganglion under the arch of the aorta.

The LOWER CERVICAL GANGLION of the sympathetic nerve is placed upon the limits betwixt the neck and thorax upon the head of the first rib, and by the side of the musculus longus colli; and it is in part covered by the root of the vertebral artery. The ganglion is of an irregular cushion-like shape. It lies close to the cervical nerves which go to the brachial plexus, and it receives branches from them. And even it receives branches sometimes from the fifth and sixth, more rarely the seventh and eighth, from the first and second of the back: and lastly, from the phrenic nerve. Branches also pass from this ganglion to the par vagum and recurrent, and also pass on to the cardiac and pulmonic plexus. That nerve, which must be considered as the continued sympathetic, throws a ring round the root of the vertebral artery, and sending out branches upon the subclavian, terminates in the first dorsal or thoracic ganglion.

### THE SUPERIOR THORACIC GANGLION.

This ganglion surpasses the other thoracic ganglions in size. It is, indeed, frequently composed of many branches of the nerve in the neck, coming both before and behind the subclavian artery. It receives also nerves from the three or four lowest cervical nerves, and first dorsal nerve. It is of a very irregular figure, or rather it varies exceedingly

in its shape; so that by various anatomists it is described as round, oval, triangular, quadrangular, cylindrical! — Filaments proceed from this ganglion into the canal of the vertebral artery, which communicate with the sixth and seventh cervical nerves, and sometimes with the fourth, by a long descending filament.* This first dorsal ganglion communicates likewise with the first dorsal pair of nerves; and gives branches to the cellular coat of the subclavian artery, and to the cardiac plexus, and also to the pulmonic plexus; or to supply the posterior surface of the lungs.

### SYMPATHETIC NERVE IN THE THORAX.

The sympathetic nerve (as we have explained in describing the dorsal nerves), through all its course in the thorax, has additional branches from the dorsal or intercostal nerves. It forms also, while it is lying on the side of the vertebræ, a division in the thorax, which it will be important to recollect. One nerve is sent more forwards upon the body of the vertebræ, and passes into the abdomen betwixt the crura of the diaphragm; while the trunk of the sympathetic continues its course by the heads of the ribs, passes over the ligamentum arcuatum, and downwards upon the lumbar vertebræ.

The SPLANCHNIC NERVE, then, is this anterior branch of the sympathetic in the thorax. It is the great nerve of the viscera of the abdomen. It generally has two or four roots from the trunk of the sympathetic nerve, where it is opposite to the sixth, seventh, and eighth intercostal nerves. It is seen lying under the pleura, and passing obliquely over the bodies of the dorsal vertebræ, from the seventh to the tenth. It then passes through the crura of the diaphragm, enters the abdomen, and forms the great semi-lunar ganglion.

One or more branches are sent forward from the sympathetic, commonly from the ganglions, opposite

* In brutes I have traced a considerable division of this nerve along the canal of the vertebral artery.

to the interstice betwixt the ninth and tenth, or tenth and eleventh ribs. These also pass the diaphragm, and unite with the semilunar ganglion. There is, however, a considerable variety to be observed both in the origins of the splanchnic nerve, and in the number of these subsidiary branches. A larger branch, going off betwixt the tenth and eleventh ribs, is so common, that it has the name of SPLANCHNICUS MINOR, OR ACCESSORIUS. This nerve as frequently terminates in the renal plexus, as in the semilunar ganglion; or sometimes it sends branches to both.

### SEMILUNAR GANGLION AND CŒLIAC PLEXUS.

The ganglion which is called the semilunar ganglion, has no regular shape — and least of all when it is fully dissected. It is formed by the splanchnic nerve, and by branches which come from the lumbar nerves. It lies by the side of the cœliac artery, and consists of many lesser ganglions, (sometimes to the number of eleven or twelve,) matted together into a glandular-like shape.

The semilunar ganglions of the splanchnic nerves lie on each side of the root of the cœliac artery; their connection with each other is frequent and intricate; so that they throw a mesh of nerves round the root and branches of this artery, which is the great source of vessels to the stomach, liver, and spleen. — This plexus, formed by the semilunar ganglions round the cœliac artery, is the solar or cœliac plexus.

### CŒLIAC PLEXUS.

The cœliac plexus is the great source of nerves to the higher viscera of the abdomen. The splanchnic nerves are the principal, not the only nerves which form this plexus. The par vagum sends branches down from the stomach which join it; and even the phrenic nerve, which is the nerve of the diaphragm, sends down twigs to unite to the branches of the

splanchnic and par vagum. We shall find also small nerves which come from the seat of the kidney, and which are derived from the superior lumbar nerves. — These pass across the crura of the diaphragm, and enter into the cœliac plexus. — In pursuing the nerves of the viscera further, we have it no longer in our power to follow individual branches, but must rather mark the course, and enumerate the various sources of the plexus, and net-work of nerves which follow the great vessels.

From the cœliac plexus, there pass out, 1. Nerves which accompany the phrenic arteries upon the lower surface of the diaphragm. 2. Nerves to the liver: — and of these there are two plexuses, the right and left hepatic plexus; one passes along the vena portæ, biliary ducts, and right hepatic artery, to the right side of the liver, the gall bladder and ducts; this of course is the RIGHT HEPATIC PLEXUS: the LEFT HEPATIC PLEXUS passes along the left hepatic artery; and this has connection with the nerves of the stomach, branches of the par vagum. 3. That plexus, which runs upon the lesser curve of the stomach, while it is formed in a great measure by the par vagum, has also connection with the solar or cœliac plexus. 4. The plexus of nerves which pass to the lower orifice of the stomach and duodenum is chiefly a division of the right hepatic plexus. These nerves, to the liver, stomach, and duodenum, are attached to the branches of the cœliac artery. Along the great splenic artery, which is also derived from the cœliac artery, there passes out a plexus of nerves to the spleen. From this splenic plexus there pass nerves to the great omentum; and they even unite with those passing out upon the duodenum, and which attach themselves to the right epiploic artery, and take a course upon the great curvature of the stomach.

Thus the solar or cœliac plexus is a great central net-work of nerves, which pass out in divisions to the liver, spleen, pancreas, stomach, duodenum, and omentum.

## SUPERIOR MESENTERIC PLEXUS.

The place and connections of the superior mesenteric plexus is at once known, when it is considered that it is formed upon the root of the superior mesenteric artery. — It is formed by a division of the cœliac plexus continued down upon the aorta so as to involve the root of the mesenteric artery, and by nerves coming over the side of the vertebræ of the loins from the lumbar nerves. This plexus spreads betwixt the membranes of the mesentery, and extends upon the branches of the artery, and is distributed to the small intestines and part of the colon. It consequently supplies the mesenteric glands, and it sends nerves also to the pancreas, that join those which it receives from the splenic plexus.

## INFERIOR MESENTERIC PLEXUS.

The same mesh of nerves, being continued down upon the face of the aorta, surround the lower mesenteric artery, and follow its branches. This is the lower mesenteric plexus, or mesocolic plexus; and it is formed in a great measure from the branches of the continued trunk of the sympathetic nerve. As this plexus spreads upon the branches of the lower mesenteric artery, it passes to the left side of the colon, and rectum. While the lower mesenteric plexus is continued from the upper one, on the side of the lumbar vertebræ, it is continuous with the renal and spermatic plexus; and towards the pelvis, with the hypogastric plexus.

Before considering the other lesser plexus of nerves in the abdomen, it is necessary to follow the continued trunk of the sympathetic nerve, which we had described as following closely the lateral part of the dorsal and lumbar vertebræ, whilst the splanchnic nerves pass obliquely over them to the viscera of the upper part of the belly.

The CONTINUED TRUNK of the SYMPATHETIC NERVE,

after it has given off the splanchnic nerve in the thorax, sends several small nerves forward over the vertebræ to the mediastinum and sheath of the aorta. It then passes the diaphragm, keeping close to the transverse processes of the vertebræ. When, however, it comes lower upon the lumbar vertebræ, it lies more upon the side of their bodies, and the connections with the lumbar nerves are by small and numerous twigs which stretch over the side of the vertebræ. In this course, it is giving off upon the fore part numerous irregular twigs to the several plexuses which have been described. Where it lies under the vessels which pass to the kidney, it sends up some branches to the renal plexus.

The renal plexus, however, is not entirely formed of these branches of the continued sympathetic, but is rather a continuation from the cœliac and superior mesenteric plexus; while the lesser splanchnic nerve, which was sent off in the thorax, also terminates in it. This plexus is thrown over the vessels of the kidney, and forms several little ganglions.

From the renal plexus descends the SPERMATIC PLEXUS with the vessels to the testicle. This plexus of nerves in woman follows the spermatic artery in its distribution to the ovaria and uterus.

In passing down upon the loins, the sympathetic nerve forms five or six ganglions with the branches from the lumbar nerves. These are oblong, angular, stellated, — irregular in their form, and in their number, situation, and size, as the twigs which, by their union with the sympathetic, form them. Betwixt these ganglions or connections with the lumbar nerves, the sympathetic is not always one nerve, but is sometimes split into several smaller nerves, which unite again. From the sympathetic nerves of both sides we have to observe frequent interchange of branches, which sometimes attach themselves to the lumbar nerves, sometimes creep under the aorta, or unite to the plexus covering the face of the aorta. — There are several little ganglions formed by these

nerves upon the face of the lumbar vertebræ: they have the name of GANGLIA ACCESSORIA.

Before the sympathetic nerve descends into the pelvis, it has become extremely delicate. In many subjects it seems to terminate in the last lumbar, or first sacral nerve; but, upon more minute dissection, lesser branches will be found to descend amongst the loose cellular substance of the pelvis. When regular, or perhaps we may say with truth when regularly and fully dissected, the sympathetic nerves of each side are seen to descend upon the fore part of the sacrum, and form connections with the sacral nerves similar to those with the dorsal nerves. As they descend, they of course approach, and finally unite in an acute point on the os coccygis. At the points of union of these extreme branches of the sympathetic nerves with the branches of the sacral nerves, small ganglions are formed; and there pass out branches from them, which cover the intermediate surface of the sacrum with an extensive plexus. The ultimate ganglion, formed by the union of the two sympathetic nerves, is the COCCYGEAL GANGLION, or, GANGLION SINE PARE, and from it there pass three or four nerves to the extremity of the rectum.

### HYPOGASTRIC PLEXUS.

This is a plexus which lies on the side of the pelvis, and involves the hypogastric artery. It consists of the nerves passing to the parts contained in the pelvis; which do not, however, pass in distinct branches, but like those of the abdomen, are formed into a minute interwoven net-work. The hpyogastric plexus takes no determinate origin, but is continuous with, or formed by, the extreme branches of the sympathetic nerve, the extremity of the spermatic plexus, the sacral nerves, (and particularly the third sacral nerve,) and by the branches of the accessory ganglions on the sacrum.

### FUNCTION OF THE SYMPATHETIC NERVE.

The opinion, borrowed from the continental writers, and more particularly from Bichat, has been entertained, that the sympathetic nerve of the human body was the same with the nervous cord found running down the centre of the *vermes*. This is paying too much respect to a name—too little attention to nature. Then again, it has been said that this part of the nervous system should be called (with Bichat), the *ganglionic system!* True, there are ganglions universally distributed wherever we find the branches of the sympathetic nerve; but what a perversion it is when we know that the posterior root of every spinal nerve has a ganglion, to call this the ganglionic system, as if it alone had ganglions, and as if it were true that ganglions cut off sensation.

The nerves of the lower animals, though they, in form, resemble the sympathetic system, possess both power over the voluntary muscles, and bestow sensibility on the parts they are distributed to. We neither observe that the sympathetic nerve possesses voluntary power over the muscles, nor that it bestows sensibility. Surely this is enough to distinguish it from the system of the lower creatures.

The ganglions on the sympathetic nerve do not cut off sensation. There is no reason for continuing in that antiquated hypothesis, since I have shown that all the spinal roots which possess sensibility have ganglions.

In short, we only know what the sympathetic nerve is not; and by that means we are left to conjecture what really are its functions. It possesses no power over the features; it is not the nerve of emotion; it does not controul any voluntary motion: it has no sensibility. But, independent of these functions, we have to consider that the parts of the frame are united into a whole; it may be by the sympathetic nerve, which is universally distributed. The nutrition and growth of the body,—the circulation and secretion,—

— the deposition and absorption of the fluids and solids of the body require some controlling influence, and there is every probability that the sympathetic nerve performs these offices, ministering to the vital and constitutional powers.

### NERVES OF THE ARM; AXILLARY, OR BRACHIAL PLEXUS.

The nerves which proceed from the spine, and go to supply the arm, are formed into an intricate plexus before they divide into the several nerves of the arm.

This brachial, or axillary plexus, is formed of five of the spinal nerves: viz. the fifth, sixth, seventh, and eighth cervical nerves *, and the first dorsal nerve. The highest of these nerves proceeds from betwixt the fourth and fifth cervical vertebræ; the last from betwixt the first and second dorsal vertebræ. They pass out betwixt the middle and anterior divisions of the scaleni muscles; and even while covered by this muscle, and before they have proceeded far from their foramina, the last nerve of the neck and first of the back unite. † — The plexus extends from above the clavicle to the edge of the tendon of the latissimus dorsi. It allows of no natural division. ‡ The axillary artery passes for some way close under it, and then perforates betwixt the divisions which form the radial nerve.

* This is of course counting the sub-occipital as the first cervical nerve.

† Before the nerves which form the plexus intermix their filaments, or are connected together, they send off small branches to the scaleni muscles, to the muscles of the spine, and to the levator scapulæ. — The branches which they give to the sympathetic nerve we have already noticed.

‡ I mean that it admits of no division useful in the arrangement of the demonstration. See Monro's Nervous System, and the Latin work of Anton. Scarpa. Scarpa describes the connection of filaments betwixt the ulnar and radial nerves at their separation from the great plexus, *Plexus brachialis minor*. Vide tab. ii. fig. ii. h.

In the plexus of the axilla, the nerves of the arm make that interchange of branches which combines the muscles of the arm into classes, and which consequently orders the action of the muscles in the several motions of the arm and hand.

Before describing the plexus, I should notice the *nervi axillares intercostales.* These nerves do not belong to the axillary plexus They come from the intercostal nerves, and, perforating the intercostal spaces, two or three nerves cross the axilla and go to the glands and integuments. — We may now arrange the nerves of the axillary plexus thus: —

1. The THORACIC NERVES. — Although the nerves which supply the muscles of the chest are derived from the intercostal nerves, as we have seen, yet there also pass off branches from the axillary plexus to the great and little pectoral muscles, to the latissimus dorsi, to the skin and mammæ. These thoracic branches proceed from the upper division of the plexus, or that which gives out the external cutaneous, and from one of the roots of the radial nerve.
2. The supra and infra-scapular nerves.
3. The circumflex, or articular nerve.
4. The perforans Casserii, or external cutaneous nerve.
5. The radial nerve (better named *median*).
6. The ulnar nerve.
7. The muscular spiral nerve.
8. The internal cutaneous nerve.
9. The nerve of Wrisberg.

Which may be arranged thus: —

| | |
|---|---|
| I. Cutaneous nerves. | 1. Nerve of Wrisberg.<br>2. Internal cutaneous nerve.<br>3. External cutaneous nerve, or perforans Casserii. |
| II. Nerves to the shoulder-joint. | 1. Supra-scapular nerve.<br>2. Infra-scapular nerve.<br>3. Circumflex nerve. |

III. To the muscles of the arm and to the fingers.
1. Radial nerve.
2. Ulnar nerve.
3. Muscular spiral nerve.

The SUPRA-SCAPULAR NERVE comes off from the upper edge of the plexus, and is the highest of the branches. It runs towards the root of the coracoid process, it passes through the notch of the scapula, and goes to supply the supra and infra spinatus muscles, the teres minor, and the sub-scapularis.

The SUB-SCAPULAR NERVES come out from the posterior part of the plexus along with the articular nerve. They are attached to the sub-scapular muscle; they turn round the fleshy edge of the muscle, and insinuate their branches betwixt the tendon of the latissimus dorsi and the teres major.

The CIRCUMFLEX, or ARTICULAR NERVE, or AXILLARIS, lies very deep. It comes from the back part of the plexus, passes behind the neck of the humerus, accompanied by the posterior circumflex artery, and above the tendon of the latissimus dorsi, and teres major. One of its branches we trace into the teres major, while another passes round the bone, and is distributed to the under surface of the deltoid muscle, the joint, and the cellular membrane.

The INTERNAL CUTANEOUS NERVE. — This nerve is derived from the ulnar at its root, or comes off from the plexus along with it; passes down the arm, giving off no considerable branches; accompanies the basilic vein, and twists its branches over it; divides into four branches upon the fascia of the fore-arm; and running betwixt the fascia and veins of the fore-arm, it is finally distributed to the cellular membrane and integuments, while one of its branches reaches to the ligaments of the wrist.

The CUTANEOUS NERVE OF WRISBERG comes sometimes from the axillary plexus, as a distinct nerve; sometimes it is a branch of the great internal cutaneous nerve; sometimes it is derived, or a nerve which takes its place is derived, from the intercostal nerves.

This nerve of Wrisberg is distributed to the integuments of the arm, and terminates near the internal condyle.

Perforans Casserii, or the external cutaneous nerve. — This nerve passes through the coraco-brachialis muscle before the os humeri, to gain the outside of the arm. From its perforating this muscle, and being described by Casserius, it is called the nervus perforans Casserii. Before passing through the coraco-brachialis muscle, it sends a nerve into the substance of that muscle. Here it also sends down a branch of communication with the radial nerve; and in many subjects it will be found to be like a branch from one of the origins of the radial nerve. Where the nervus perforans lies betwixt the brachialis internus muscle and biceps, (and, of course, after it has perforated the coraco-brachialis muscle,) a branch or two are sent up to the heads of the biceps muscle; another branch turns inward to the belly of that muscle; another is given to the brachialis internus; and, finally, twigs pass inwards to the cellular membrane, which involves the brachial artery.

The continued nerve passes obliquely across the arm, and under the biceps. When approaching the outside of the arm, it divides into three small branches; one to the integuments which are upon the supinator longus, another to the integuments on the inside of the fore-arm, and a third, which continues its course along the edge of the supinator longus to the wrist. Of this prolonged branch of the perforans Casserii, a minute twig is lost on the ligament of the wrist, another passes to the ball of the thumb, and a third goes round to the integuments of the back of the thumb.

The radial or median nerve. — This nerve is formed by those divisions of the plexus which surround the brachial artery, and sometimes by a division from the perforans Casserii. It takes its course in the upper part of the arm by the outer side of the

brachial artery. In the middle of the arm it crosses the artery superficially, and continues to lie on its ulnar side, separated from it by some thin cellular membrane, as far as to the bend of the arm. It gives off no branches until it has sunk under the aponeurotic expansion of the biceps muscle.

When the median nerve has come to the bend of the arm it gives off three branches. The first belongs to the pronator teres, flexor radialis, palmaris longus, and flexor digitorum; a second passes to the pronator teres; a third to the deep muscles of the fore-arm, to the flexors of the thumb particularly; and from this a fine branch attaches itself to the interosseous membrane, and, taking its course with the anterior interosseous artery, is distributed to the pronator quadratus muscle. The median nerve perforates the pronator teres, and then, continuing its course down the fore-arm betwixt the flexor sublimis and profundus digitorum, sends off branches to those muscles; and in this part of its course we see why the name *median* is more applicable than *radial.* Before passing under the ligament of the wrist, it gives out a branch which emerges from the tendons, and passes to the integuments, short flexor, and abductor muscles of the thumb.

The trunk of the median nerve passes with the tendons of the flexor muscles of the fingers under the ligament of the wrist. In the palm of the hand it divides into five branches: — the first passes to the abductor and flexor pollicis brevis; a second goes to the adductor pollicis, and side of the thumb next the fore-finger; the third passes to the fore-finger, and to the lumbricalis muscle; the fourth to the side of the fore and middle fingers; and the fifth to the sides of the middle and ring finger. All these nerves, while in the palm of the hand, send off branches to the lumbricales muscles.

The ULNAR NERVE comes off from the lower part of the plexus, in union with the internal cutaneous

nerve. It descends upon the inside of the arm, accompanied by the inferior profunda artery, and is tied down by the firm intermuscular fascia, and then passes behind the internal condyle of the humerus. While above the bend of the arm, it gives off a superficial branch to the integuments on the inside of the arm, and the ulnar side of the fore-arm; at the same time it sends a muscular branch through the triceps muscle, along with the arteria profunda inferior. Immediately above the elbow-joint, twigs are sent off, some of which accompany the ramus anastamoticus major of the brachial artery. After passing the condyle of the humerus, it sends a branch to the flexor carpi ulnaris, and to the head of the flexor digitorum profundus. It then sinks deeper betwixt the flexor ulnaris and flexor digitorum sublimis; it is here connected with the ulnar artery, and descends along with it to the wrist, lying on its ulnar side; when it approaches to the annular ligament, it is rather posterior to the artery. In this course, along the fore-arm, the ulnar nerve gives branches to the flexor digitorum sublimis. Often it sends a branch of communication to the median nerve, while some few lesser muscular nerves are sent off, and accompany the branches of the ulnar artery.

When arrived near the wrist, the ulnar nerve divides into two branches. The continued trunk passes on under the protection of the tendon of the flexor ulnaris, and then under the annular ligament into the palm of the hand; while a branch, the ramus posticus, takes a turn under the flexor ulnaris, and over the edge of the flexor digitorum profundus; — it passes then over the lower end of the ulna to the back of the hand; on the back of the hand it is found branching over the expanded tendons and under the veins, and is finally distributed to the back of the little and ring fingers.

The continued ulnar nerve passes under the palmaris brevis muscle and palmar aponeurosis, and above the

flexor brevis and adductor minimi digiti. Here it divides into two, viz. the sublimis and profundus of Camper. The superficial branch passes by the side of the abductor minimi digiti to the integuments on the ulnar edge of the hand,· and adductor minimi digiti, — to the outer edge of the little finger, — to the side of the little and ring fingers, and a branch communicates with the median nerve.

Albinus, Monro, and Camper differ in their description of the nerves to the lumbricales muscles, which only proves that the twigs passing to those little muscles are irregular. They come from the deep branch of the ulnar nerve. The deep branch (*profundus*) forms a deep palmar arch, and is sent to the lumbricales, to the adductor and flexor pollicis.

The MUSCULAR SPIRAL NERVE. — We find the external cutaneous nerve, or perforans Casserii, passing before the arm-bone. The muscular spiral nerve, on the contrary, passes behind the bone, and takes a spiral turn under it to get to the outside of the arm. It perforates the flesh of the arm betwixt the middle and the short head of the triceps muscle. Before it perforates the triceps muscle, the muscular spiral sends off branches which pass over the tendon of the latissimus dorsi; and before it enters the triceps muscle, it may be observed to divide into several branches. Three of these may be mentioned; a branch to the middle head, and one to the short head of the triceps muscle; and a third and larger nerve, which pierces betwixt the muscles, along with the trunk of the nerve.

This last nerve does not follow the trunk of the nerve in its course; but perforating the triceps more directly across, it comes out behind the supinator longus, where it takes its origin from the os humeri. This is a cutaneous branch, and might be considered as the external cutaneous nerve with as much propriety as the perforans Casserii. Often we shall find some lesser branches of the muscular spiral nerve

piercing the fibres of the triceps muscle, and terminating in the skin.

The great division of the nerve, after piercing the triceps muscle, lies betwixt the brachialis internus and the inner edge of the supinator longus; and here it sends a branch upon the bend of the arm, and on the edge of the triceps muscle. Where it is near the elbow-joint it divides into the *nervus profundus* and *superficialis:* the profundus gives branches to the extensor carpi radialis: then perforates the supinator radii brevis; twists round the radius; and here divides amongst the extensor muscles, sending branches to the extensor carpi ulnaris, to the extensor pollicis, and primus, secundus pollicis; the extended nerve keeping still under the extensor tendons, passes to the back of the wrist, and is lost under the insertions of the extensores radiales.

But the great superficial division of the muscular spiral nerve comes out betwixt the head of the supinator longus muscle and the joint. This branch then lies betwixt the supinator longus and pronator teres. Continuing its course by the side of the supinator longus and flexor radialis, on the outer side of the radial artery, it passes under the tendon of the former, it then becomes superficial, on the radial edge of the wrist, and is distributed to the integuments of the back of the hand, back of the thumb, fore, middle, and ring fingers. This branch is sometimes called *radial.*

## NERVES OF THE THIGH, LEG, AND FOOT.

In tracing the nerves of the lower extremity, we find no difficulty in the arrangement, for they fall into a very simple and natural order. They are all derived from the lumbar and sacral nerves. They are three in number. 1. One passes out under Poupart's ligament to the extensor muscles of the leg, viz. those which lie on the forepart of the thigh.

This of course is called the *anterior crural nerve.* 2. The second nerve is the *obturator nerve,* so called because it passes out from the pelvis by the obturator hole. This nerve passes out in the middle of the pelvis, lies amongst the deep muscles of the thigh, and distributes its branches chiefly to the adductor muscles. 3. The third nerve is the greatest nerve of the body. We may call it the *posterior crural nerve,* its proper name however is the *ischiatic nerve.* It passes out from the back part of the pelvis, through the sacro-sciatic notch, and takes its course down the back of the thigh into the ham. In this course it supplies the muscles lying on the back of the thigh, but its chief destination is to the leg and foot.

But before we attend to these three principal nerves of the lower extremity, we must notice the lesser nerves, which pass out from the pelvis, and which, indeed, are not without interest.

### LESSER NERVES WHICH PASS OUT FROM THE PELVIS.

The cutaneous branches of nerves which have their source internal, are always important, because the internal affection, as in the present instance of the kidney, the intestine, the uterus, are attended with external pains, or pains felt as if they were external, and these will often guide us to the real source of the disease. There are three divisions of nerves which deserve attention for this reason; first, those cutaneous nerves which, coming off from the lumbar nerves, drop over the spine of the ilium upon the integuments of the hip and thigh. Secondly, there are nerves which course from the loins round in the spermatic passage, and go to the scrotum and membranes of the testicle, and turning up from the groin pass to the integuments of the pubes. In the third class are those nerves which go down upon the integuments of the thigh.

These cutaneous nerves of the thigh come from

the lumbar nerves, or more immediately from the anterior crural nerve. They pierce the tendon of the oblique muscle of the abdomen, or pass under Poupart's ligament, and are distributed to the groin, scrotum, and betwixt the fascia and integuments of the fore part of the thigh. There may be described four cutaneous nerves on the fore part of the thigh, viz. the *external cutaneous*, the *middle cutaneous*, the *anterior cutaneous*, the *internal cutaneous*, besides those of the groin and scrotum.

The EXTERNAL CUTANEOUS NERVE is that which comes out from the belly near the superior spinous process of the ilium. It is derived from the third lumbar nerve. It divides almost immediately into two great branches, and in the front view of the thigh the anterior branch alone is to be seen. It takes a course above the fascia in the direction of the line which divides the vastus externus from the rectus femoris, and terminates near the knee; while the posterior branch passes over the tensor vaginæ femoris, and down upon the outside and back of the thigh.

The MIDDLE CUTANEOUS NERVE is seen amongst the integuments of the groin, and emerges from under the fascia near the upper edge of the Sartorius muscle. It passes down upon the rectus muscle, and is distributed to the integuments in three or four divisions.

The ANTERIOR CUTANEOUS NERVE comes out to the integuments very high up, in the middle of the groin, betwixt the pubes and spine of the os ilii. It passes down the thigh along the surfaces of the Sartorius and vastus internus muscles. This, like all the other cutaneous nerves, runs above the fascia, and immediately under the skin.

The INTERNAL CUTANEOUS NERVE is the least regular. It does not pierce the fascia in one trunk, but sends three, four, or five branches through the fascia, which are distributed to the integuments on the inside of the thigh. Some of these, after running

a considerable way under the fascia, emerge and encircle the inside of the knee.

We must not dismiss the consideration of those nerves without putting the knowledge of their distribution to some use. Suppose that a nerve of the spine divides into two, and that one branch goes internal to the viscera, and the other external to the integuments; it will come to pass that all internal morbid irritations will produce sensations attributable to the part to which the external or cutaneous nerve is distributed. These pains will not be easily described, and the terms the patient uses, too frequently, appear, therefore, fanciful.

Is this a sufficient explanation of the pain actually seated in the throat, affecting the back of the neck? The disorder actually seated in the heart, affecting the mammæ and arms? The disease of the lungs producing pain, referable to the back, betwixt the scapulæ? The inflammation of the liver, and the irritation of the diaphragm, pain in the shoulder? Disorders actually seated in the stomach, produce an extensive class of sympathetic pains. But the disorder of the duodenum is distinctly referable to the lower part of the back, as the distention of the colon, or the lodgement of matter there, produces pain in the loins and region of the kidney.

When we come to the contemplation of these nerves of the loins, the subject does not diminish in interest or usefulness.

1. Disordered function of the womb, conception, quickening, delivery, after-pains, menstruation, &c. produce pain in the lower part of the back and loins.

2. The disease of the testicle produces similar pain in the loins.

3. Disorder of the bladder often produces pains in the groin and perinæum.

4. Disorder in the rectum, or irritation of fæces there, produces pains in the perinæum, &c.

5. Lastly, diseases in the kidney and ureter, produce pain down the fore part of the thigh, and retraction and pain in the testicle.

### THE PUDIC NERVE.

The pudic nerve comes off from the third, fourth, and fifth of the sacrum, holding connection with the roots of the great ischiatic nerve. It runs towards the outlet of the pelvis, and to the side of the tuber ischii. In the female it sends branches to the anus, vulva, and clitoris. In the male it accompanies the common pudic artery in its course, and it consequently runs to the muscles of the anus, and of the perinæum, to the caput gallinaginis, to the penis, and to the glans, in many branches: and here it is the organ of a peculiar sense. Besides being the organ of venereal sensation, it bestows the sensation which orders the contraction of the bladder, not only furnishing us with these sensations in addition to the common sensibilities, but under the influence of these sensations it controuls the various necessary actions of the muscles.

## NERVES OF THE LOWER EXTREMITY.

### ANTERIOR CRURAL NERVE.*

This nerve arises from the union of the second, third, and fourth of the lumbar nerves, or the second and third lumbar nerves uniting into one trunk, are afterwards joined by a division of the fourth †, or the anterior crural, is formed by the anterior branch of the third and the first branch of the second lumbar nerve ‡, or by the four first lumbar nerves; and the first sacral nerve. At its origin, it lies under the psoas magnus, and, as it descends, it holds its course

* *Crural nerve, truncus lumborum, femoralis magnus.*

† Fischer.—Walter.

‡ Sabbatier and Haller.

between the psoas magnus and iliacus internus. It then descends towards the thigh, and passes out under Poupart's ligament; and in its course along the brim of the pelvis, it is quite removed from the external iliac artery. Here, while within the pelvis, it gives off several small nerves, which pass into the iliacus internus, and to the psoas magnus muscles. These form a kind of small plexus.

As the anterior crural nerve passes under Poupart's ligament, it is imbedded between the iliac and psoas muscles, and lies about half an inch to the iliac side of the femoral artery. It here splits into its numerous branches which supply the muscles and integuments on the fore part of the thigh. From the fore part of the nerve there is sent out a musculo-cutaneous branch, which, while it descends and supplies several muscles of the thigh, gives out the middle cutaneous nerve. The anterior cutaneous nerve is sent off lower down. But almost immediately after it has passed under Poupart's ligament, the internal cutaneous nerve is sent off from some of those branches which run under the internal articular artery.

The last of the cutaneous branches of the anterior crural nerve, and the most important, is the NERVUS SAPHENUS, OR CUTANEUS LONGUS. This is the chief cutaneous nerve of the leg; but it is to be distinguished as a particular nerve, so high as under the external articular or circumflex artery, being a division of what is called the NERVUS LONGUS. This nerve is joined by a branch of the obturator nerve; and about the same place muscular branches are given off to the vastus internus.

When we are dissecting in the course of the femoral artery, we have to observe two nerves running parallel to and connected with the sheath of the artery. That which is on the inside is the largest, the course of which we shall prosecute. It follows the artery, lying along its outer side, and rather before it, as far as the tendon of the triceps muscle; it

is here enclosed in a firm fascia, but it does not descend into the ham with the popliteal artery. It passes along the tendon with the perforating branches of the popliteal artery, or with the upper and internal articular artery. It then becomes a superficial nerve, having passed between the tendons of the gracilis and Sartorius muscles, and descends upon the inside of the leg with the saphena vein, to the inner ancle and foot.

This nerve, which lies near the femoral artery in the middle of the thigh, I have seen taken up with the extremity of the artery in amputation. This occasions twitching in the stump, and a good deal of distress.

Where the continued nerve descends upon the inside of the leg, it sends out many twigs to the integuments, and is entangled with the saphena vein. It has been pricked in bleeding in the ancle.— Sabbatier gives us an instance of this. The patient had been previously subject to nervous affections. She felt in the instant of the operation an acute pain, which was succeeded by convulsive motions, first of the limb, and then of the whole body. These attacks returned from time to time, she lost her health, and for many years was in great suffering. He relates to us another instance of the injury of this nerve accompanying the saphena vein, in the case of a young man who received a wound with the small sword in the inside of the knee. There came on much fever and swelling of the part, with great pain of the limb. This subsiding, there followed slight trembling of the limb, which gradually increased to an extreme degree. The caustic was proposed, but the patient had not resolution to let it be applied. After long suffering, with exhausted strength, he was at last relieved by nature, and his health gradually returned. When the nerve passes over the tibia, it is subject to be bruised, and I have seen tetanus proceed from such an injury.

These branches we have mentioned are only the cutaneous or superficial branches of the anterior crural nerve. The larger and more numerous set of branches are those to the muscles lying on the fore part of the thigh. These diverge suddenly in many twigs, and are entangled with the branches of the arteries, and follow them in their distribution. There can be no excuse for bestowing particular names on these branches; — to say that one is the branch to the pectinalis, another the branch to the Sartorius, another to the rectus, &c. is sufficient.

### OBTURATOR NERVE.

This nerve arises in common with the anterior crural, from the third and fourth lumbar nerves, or we say it arises by fasciculi from the second and third lumbar nerves, and sometimes by a small twig from the fourth. It lies under the internal border of the psoas magnus. It descends into the pelvis, and goes obliquely downwards to pass through the ligamentous membrane which fills up the thyroid hole. The obturator nerve, before it escapes from the pelvis, sends off a branch which, accompanying the parent nerve, is given to the external obturator muscle. When it has escaped from the pelvis, this nerve lies in the middle of the flesh of the thigh; here it divides into a deeper and more superficial branch; the more superficial lies betwixt the adductor longus and brevis, and divides into three branches. These divisions pass to the adductor longus, adductor brevis, and the gracilis. The branch which passes to the adductor longus, sends a small nerve under the inner edge of that muscle, and down through the tendon of the triceps to the inside of the vastus internus, and there it unites with the nervus saphenus, and then passes betwixt the adductor longus and brevis. The posterior division of the obturator goes down betwixt the adductor magnus and brevis,

sends branches to the obturator externus and adductor brevis, and continues its course downward before the great fleshy partition of the adductor muscles, and parallel with the crural vessels, to the fat above the inner condyle of the femur, and to the skin.

### THE ORIGIN OF THE ISCHIATIC NERVE.

The ischiatic nerve is formed by the two last nerves of the loins, and the three first of the sacrum: or we may describe its origin more particularly thus; the anterior branch of the fourth lumbar nerve and the trunk of the fifth uniting, form a strong cord of about two inches in length: this root is joined to another nearly as large, formed by the first and second sacral nerves; and again, a third division joins it from the inferior branch of the second sacral nerve and from the third.* The ischiatic nerve is thus formed of three great roots matted together into a kind of plexus. It is flat to escape from pressure; it passes backwards betwixt the pyriformis muscle and the gemini, and thus escapes from the back part of the pelvis by the great ischiatic notch.

But before following this great nerve into the thigh, we must take notice of some lesser nerves sent out from the sacral nerves, and from the trunk of the ischiatic nerve. These nerves pass to the muscles and integuments of the nates and back of the thigh to the perinæum and private parts.

There pass off one or two very small nerves from the body of the ischiatic nerve, while yet within the pelvis, or from the middle divisions of its origins, which go to the pyriformis and glutæus medius muscles.

Just where the great nerve passes over the posterior

* This third and lowest origin, before uniting with the others to form the ischiatic nerve, gives out many small branches to the hypogastric plexus and viscera of the pelvis, to the perinæum and private parts.

ligaments of the pelvis, there goes off a twig to the obturator externus, gemini, and quadratus femoris. While these branches are sent off upon the anterior face of the nerve, there goes backward a large fasciculus of nerves to the glutæi muscles, and to the integuments of the nates.*

When the integuments are dissected off from the nates and back of the thigh, we see two sources of the cutaneous nerves; first, from the lumbar nerves come many small nerves which pass over the spine of the os ilii; and, secondly, from under the lower margin of the great glutæus muscle, there come many extensive cutaneous nerves, of which that last described is the principal.

A little further down, the ischiatic nerve gives off small nerves to the muscles surrounding the hip-joint; and, whilst the sciatic nerve is passing over the quadratus femoris, the INFERIOR and INTERNAL CUTANEOUS NERVE is given off. This nerve runs down even to the inside of the calf of the leg.—The EXTERNAL and POSTERIOR CUTANEOUS NERVE is a branch sent off from the ischiatic nerve, after it has descended from under the glutæus maximus, and just before its division into two fasciculi, viz. the tibial and peronæal nerves. This external and posterior cutaneous nerve passes down upon the integuments of the back part and outside of the leg.

## OF THE TRUNK OF THE ISCHIATIC NERVE IN THE THIGH.

But we must not allow these lesser branches to distract our attention from the general course of the

* The *posterior cutaneous nerve* arises within the pelvis from the sacral nerves, and connecting itself with the sciatic as it escapes, it afterwards descends upon the integuments on the back of the thigh; it sends branches also to the skin about the anus, and to the back part of the scrotum: pains are felt in the course of this nerve from disorder in the rectum.

great nerve, which passes over the gemini muscles, betwixt the tuberosity of the ischium and the trochanter major, then runs deep under the bellies of the hamstring muscles, and is lodged immediately in the great cavity behind the knee-joint, in company with the popliteal artery and vein. In this course the sacro-sciatic gives off branches to the quadratus femoris, the biceps cruris, semitendinosus, and semimembranosus and triceps.

A little below the middle of the thigh, the great ischiatic nerve divides into the internal and greater, and the lesser and external popliteal nerves. But as this is really the division into the two great nerves of the leg, they take the more determinate names of tibial and fibular nerves.

### TIBIAL NERVE.

The greater and more internal of these divisions of the popliteal nerve is the tibial nerve. Whilst it is yet in the hollow behind the joint formed by the hamstring tendons, it gives off a nerve which comes out from the ham, and descends superficially on the back of the leg. This has been called RAMUS COMMUNICANS TIBIALIS. When this nerve has arrived opposite to the beginning of the tendo Achillis, it turns a little to the outer side, passing upon the outer margin of the Achilles tendon, over the outer side of the heel-bone, and is finally distributed on the outside and fore-part of the foot. Upon the back of the leg, this nerve unites with a branch descending from the fibular nerve, nearly in the same course, and with the same destination.

After giving off this superficial branch, the tibial nerve sends branches to the back of the knee-joint, and popliteus muscle, to the plantaris muscle, and to both heads of the gastrocnemius. It then descends behind the articulation, and behind the head of the tibia. It then passes under the origins of the solæus, and betwixt the solæus and flexor longus digitorum

pedis, and tibialis posticus, and descends to the inner ankle, braced down by a very dense fascia. In this course it furnishes many branches to the lower part of the popliteal muscle, to the tibialis posticus, to the flexor communis digitorum, and to the flexor pollicis longus, and many of these branches end in cutaneous twigs. We have also to observe a particular branch which the tibial nerve detaches, which passes betwixt the heads of the tibia and fibula, and goes to supply the muscles arising from the fore-part of the interosseous ligament. Further down, two or more small branches of the nerve also perforate the interosseous ligament, to supply the muscles lying on the outside of the tibia. The tibial nerve, in its course amongst those posterior muscles, accompanies the posterior tibial artery, lying on its outer or fibular side. When it has arrived behind the inner ankle, it sends off a branch to the integuments of the inside of the foot, and to the abductor muscle of the great toe. Continuing its course by the side of the heel-bone, and under the ligament, it begins to split into those branches which are naturally called the plantar nerves, because of their lying in the sole of the foot.

## THE PLANTAR NERVES.

The internal plantar nerve passes over the abductor muscle of the great toe, and by the inside of the short flexor to the first metacarpal bone; and in this course it gives out several twigs to the muscles of the sole of the foot. It now divides into three branches. These are distributed to the great toe, to the second, the third, and one side of the fourth toes; and these nerves in their course give branches to the lumbricales and interossei muscles.

The external plantar nerve is the lesser of the two. It gives branches to the short flexor and adductor of the little toe, and to the massa carnea Jacobi Silvii. It gives also a deep branch to the

third and fourth interosseous muscle and adductor muscle of the toe. Another of its branches makes the arch with the internal plantar nerve, while its extreme distribution is to the little toe, and to one side of the fourth toe. These nerves of the sole of the foot are connected with the internal and external plantar arteries, and are protected like them by the plantar aponeurosis.

### THE FIBULAR NERVE.

The fibular nerve is the more external division of the popliteal nerve. It separates from the tibial branch about four inches above the knee-joint; it does not pass down under the gastrocnemius, like the tibial nerve, but turns towards the outside of the joint, and passes round the head of the fibula, and under the origin of the peronæus longus. — Before the fibular nerve passes from behind the joint, it gives off several branches. There are sent down two branches to the integuments. One of these branches unites with the communicans tibialis, and descends with it to the outer ankle. Sometimes this anastomosis is formed high in the leg upon the heads of the gastrocnemius. More generally there is a double communication formed by these nerves, about the termination of the belly of the gastrocnemius muscle in the Achilles tendon. This prolonged branch of the fibular nerve terminates upon the side and upper part of the foot, and upon the little toe. There are also some nerves sent off from the fibular, which are distributed about the back and sides of the knee-joint.

When the fibular nerve has turned over the head of the fibula, it divides into two great branches. The DEEPER SEATED of THESE BRANCHES, though it is not the largest of them, may be considered as the continued trunk. It passes deep amongst the muscles, lying betwixt the tibia and fibula, and supplies the

tibialis anticus, the extensor communis digitorum, extensor longus pollicis, and the peronæus brevis. Thus the deeper division of the fibular nerve, taking its course between the tibialis anticus, and the peronæus longus muscles, and lower down betwixt the tibialis and extensor pollicis longus, continues giving off branches in rapid succession, and when it arrives at the annular ligament it is much diminished. Here it divides into the *ramus dorsalis pedis profundus*, and *superficialis*. — This division is made after the nerve has crossed under the tendon of the tibialis anticus muscle, and while it lies betwixt the lower heads of the tibia and fibula. — Although they are distinguished by the name of deep and superficial branches, they are both deep compared with the extremities of the great and outer division of the peronæal nerve. The branch which lies most towards the outside of the foot passes under the extensor digitorum brevis muscle, and on the outside of the tarsus. It distributes its branches to the extensor digitorum brevis, and interossei muscles. That branch which is more towards the inside of the foot, although distinguished by the term superficialis, goes forward not only under the fascia which covers the foot, but also under the tendons; and after dividing and again uniting, and after sending off some small branches, it comes out betwixt the great toe and the second toe, and sends numerous branches to their contiguous surfaces.

The GREAT SUPERFICIAL DIVISION of the FIBULAR NERVE is sometimes double, or immediately splits into two. Its first branches are to the peronæus longus, extensor longus digitorum, and to the peronæus brevis and tertius. The trunk or principal division runs down under the head of the peronæus longus, and then coming out from under it, continues its course beneath the strong aponeurosis, which covers the muscles on the fore-part of the leg. It then pierces the aponeurosis and becomes cutaneous, and runs obliquely down to the convexity of the foot,

giving off in its course a nerve which passes over the outer ankle.

### THE METATARSAL NERVES.

When the superficial branch of the peronæal nerve descends before the ankle-joint, it divides into the metatarsal nerves, or the rami dorsales pedis. The EXTERNAL of those branches passes above the tendons, and above the tendinous expansion on the dorsum pedis; is united to the extreme branches of the ramus communicans tibialis, and is finally distributed to the outside of the third toe, to the fourth, and to the inside of the little toe. — The INTERNAL branch is again subdivided; one branch extends over the middle of the foot to the second and third toes, while the other passes straight along the metatarsal bone of the great toe (above the tendons); sends many branches over the inside of the foot, and terminates on the inside and dorsum of the great toe.

The nerves of the lower extremity have the same connection with the visceral nerves, or the system of the sympathetic, that the nerves of the arm have, and this connection is further proved by various sympathies; the influence of cold feet on the bowels, the effect of cold water dashed on the legs to promote a purgative, the spasms of the legs in cholera, pains in the knee preceding a fit of the bile.

END OF THE SECOND VOLUME.

LONDON:
Printed by A. & R. Spottiswoode,
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